Publications of the Royal Society of Victoria, and of the Societies amalgamated with it.

VICTORIAN INSTITUTE FOR THE ADVANCEMENT OF SCIENCE.
Transactions. Vol. 1. 1855.

PHILOSOPHICAL SOCIETY OF VICTORIA.
Transactions. Vol. 1. 1855.

These two Societies then amalgamated and became:—

PHILOSOPHICAL INSTITUTE OF VICTORIA.
Transactions. Vols. 1–4.

The Society then became:—

ROYAL SOCIETY OF VICTORIA.
Transactions and Proceedings (Vol. 5, *entitled* Transactions). (8vo). Vols. 5–24.
Transactions. (4to). Vols. 1, 2, 3 (Pt. 1 only was published), 4, 5, 6——1888——.
Proceedings (New Series). (8vo). Vols. 1——1888——.

MICROSCOPICAL SOCIETY OF VICTORIA.
Journal (Vol. 1, Pt. 1, *entitled* Quarterly Journal). Vol. 1 (Pts. 1 to 4), 2 (Pt. 1), title page and index [*all published*]. 1879–82.

[*The Society then combined with the* ROYAL SOCIETY OF VICTORIA].

NOTE.—*Most of the volumes published before 1890 are out of print.*

PROCEEDINGS

OF THE

Royal Society of Victoria.

VOL. XXXIV. (New Series).

PARTS I. and II.

Edited under the Authority of the Council.

ISSUED 31st OCTOBER, 1921, and 31st MAY, 1922.

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THE AUTHORS OF THE SEVERAL PAPERS ARE INDIVIDUALLY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

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CONTENTS OF VOLUME XXXIV.

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CONTENTS OF VOLUME XXXIV., PART I.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. I., 1921].

Art. I.—*Blood and Shade Divisions of Australian Tribes.**

By Sir BALDWIN SPENCER, K.C.M.G., F.R.S.

[Read 10th March, 1921].

Very much confusion and uncertainty exist in regard to what have been described as the blood and shade divisions of Australian tribes.

The first really definite allusion to anything of the kind is probably that of Bunce in 1895.[1] He says: "The merest observer, who has had the least experience travelling through the bush, must have remarked that there exists a vast difference of complexion in the different individuals comprising the various tribes. It is this difference in complexion which constitutes the *castes* spoken of by Dr. Leichardt. The tribe of aborigines, to which my attention was first directed, in whom I observed this very singular feature in crossing the blood, were a tribe inhabiting a portion of the country on the Condamine River, called Terreboo, now fully occupied by the squatters, among whom are John Dangar and Richard Birrell, Esquires. It was the latter gentlemen who furnished me with many interesting particulars relating to the Terreboo tribes.

"The two castes were distinguished by the words Cobbi, masculine; and Cobbitha, feminine; Hippi, masculine; and Hippitha, feminine.[2] The first, or Cobbi and Cobbitha, are those having the blackest complexion, and the latter are those many shades lighter. In their unions, marriages between sexes of the same castes are strictly prohibited, or in other words, a Cobbi must join his fate with that of a Hippitha, and *vice versa*."

The late Mr. R. H. Mathews[3] stated that a form of kinship organisation existed which he described as "Bloods and Shades,"

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* Read at the Hobart meeting of the Aust. Assoc. Adv. Sc., held in Melbourne, Jan., 1921.

1. Bunce, "Language of the Aborigines of the Colony of Victoria, etc," 1859, p. 59.

2. Cobbi and Cobbitha are evidently the equivalents of the now well-known Kubbi and Kubbitha; Hippai and Hippitha those of Ipai and Ipatha. The existence of two other "castes" seems to have escaped the notice of Mr. Bunce and his informant, as also that of the two moieties, Kupathin and Dilbi. We may conclude that their knowledge of the natives was very imperfect and unreliable.

3. Mathews, R. H. Proc. R.S., N.S.W., 1905, p. 215

though he seems rather to have confused the words "shade" of blood, and "shadow" or "shade" cast by a tree. Mr. R. H. Mathew's account is very vague, and somewhat difficult to understand, as it seems to refer to some form of organisation running, as it were, across the ordinary, normal organisation. It must also be remembered that he was dealing with very decadent tribes, who had, for nearly half a century, been in contact with white men, and whose numbers also were so depleted that, of necessity, old marriage customs had become profoundly modified, whilst more important still the beliefs of their forefathers were to them, for the most part, only a matter of past history in which they took practically no interest.

Recently Mrs. Langloh Parker[4] stated that the moiety names of the Euahlayi tribe in New South Wales indicated "light blooded" and "dark blooded" respectively. Mrs. Bates[5] in regard to S.W. Australia states that two of the sub-class, but not class or moiety, have in addition to their ordinary ones of Tondaroop and Ballarook, names indicating fair- or dark-skinned people, though it must be remembered that the earlier investigators gave these names, respectively, as fish-hawk and opossum. Mrs. Bates also says that "the two class system, similar to that of the Dieri, but with different names, obtains in the south-west of Western Australia, and also bears on colours—white cockatoo and crow, light and dark purple. . . . Somewhere south-east of Coolgardie the four class system dies out and, as the natives of the south-east say, 'marriages and relations go by faces (probably light and dark colour).'"

The Rev. J. Mathew[6] states that the well-known moiety names in the Kamilroi tribe, Dilbi and Kupathin, indicate light and dark blood and complexions, and that Kilpara and Mukwara, two equally well-known moiety names, mean, not eagle-hawk and crow, as he had previously told us when writing in support of his bird-conflict theory, but really straight and curly hair. He also states that in the Kabi and Wakka tribes, "the four gradations of colour correspond to the four classes."

One cannot help wondering whether these kaleidoscopic changes and variations in the meaning of names of which, at

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4. Parker, Mrs. Langloh. "The Euahlayi Tribe," 1905, p. 215.

5. Bates, Mrs. Daisy. "Social Organisation of Some West Australian Tribes," Report A.A.A.S., Melbourne, 1913.

6. Mathew, Rev. J. "Two Queensland Tribes," 1905, pp. 32, 35, 142. Journal Anth. Inst. Great Britain, Vol. xl., 1910, pp. 35 and 166. "Eagle-hawk and Crow," 1899.

all events in certain cases, the natives themselves have only a dim, very unreliable and inconsistent knowledge, but are fitted in to suit a theory either of the conflict of curly and straight haired men, dark and light coloured, or sluggish and rapid blooded peoples, are not due to the desire of the natives to explain the long lost significance of the moiety names.

On philological grounds Mr. Mathew has attempted to show the equivalence of various moiety names to one another, and has attributed to them meanings, such as eagle-hawk and crow, which, in certain cases, are either apparently quite unknown to the natives who use them, or concerning the exact application of which the natives themselves are uncertain.

Philological evidence derived from tribes that have no written language, amongst whom words are continually changing, and amongst whom, further, the same word in different tribes may have quite a different meaning, more especially when, in order to homologise words in use in various tribes, such as the names of moieties, the elision or insertion of consonants, and a change of vowels is necessary, must be received with the greatest caution.

Whilst fully realising that the question of "Bloods and Shades" requires further investigation, more especially in view of the fact that Dr. Rivers has drawn attention to a somewhat similar feature in regard to the dual organisation in certain parts of Melanesia, there are certain serious difficulties that arise on closer examination of the matter so far as the evidence as yet brought forward is concerned. I venture to suggest that the reporters of such evidence as we possess, so far at least as it relates to Australia, have scarcely recognised sufficiently what it implies in regard to the colour sense and knowledge, both anatomical and physiological, possessed by the aboriginals. In the first place, when we are told that the Australian aboriginal actually distinguishes the shades of colour of skin and blood, or the straightness or curliness of hair, we may feel quite certain that we have not arrived at the true significance of the matter. I have tested natives in many Australian tribes in regard to their colour sense by means of the recognised colour tests. So far as my experience goes they only differentiate between, and have distinct names for, what we call black, white, red and yellow. I am, of course, only speaking of the aboriginal in his natural state. This is to be associated with the fact that charcoal, gypsum or pipeclay, red and yellow ochre are practically the only colour materials available to him for use during the performance of his ceremonies, and therefore his appreciation of colour has been limited to these few pigments. Just as in the development of colour amongst flowers, blue is the highest and latest, so amongst human beings blue seems to have been the latest pigment discovered and appreciated, and it was not, so far as I am aware, before the white man, most unfortunately, introduced Reckitt's Blue into Australia, Melanesia and Polynesia, thereby spoiling aboriginal art, that the savage had any distinct appreciation of this colour. In the Kakadu tribe, for example, the same word is used for blue and green, and the natives do not discriminate between the two, nor do they between black, brown and grey. It is not a case of having one word to describe two or three colours which in reality they differentiate, but they do not, apparently, distinguish the one from the other.[7] One day amongst the Kakadu tribe, on the Alligator River in the far northern part of the Territory, I was sitting under a grove of banana trees, and three natives, with whom I was discussing the question of colour, told me that the green leaves all around and above them were the same colour as the sky. It may be said in passing that the presence of a blue pigment on any Australian ornament or implement that finds its way into one or other of our museums is regarded by all Curators as clear proof that the tribe from which it comes has lost its primitive outlook on art.

It appears to me that the theories of Mr. Mathew and others postulate a fine colour sense that at least our Australian aboriginal does not possess. Not only is this so, but, after most careful examination, made again with the aid of standard colour tints, comparing these with the actual colour of the skin of very many natives in various tribes, I have not been able to discriminate in any way between the colours of the members of the different moieties or classes of any tribe. In the southern Arunta the colour of the women was slightly, but only

7. It is somewhat difficult to express this matter accurately. If shown black, brown and grey objects, such as skeins of wool, or coloured cardboard, they will apply the same term to each. On the other hand, if (a) shown an object of a particular shade of colour such as their own skin, and (b) asked to match this with one of three or four shades of chocolate brown, they will, after consideration, usually pitch on the correct one. Black, brown and grey are apparently, to them, only what we should call "shades" of the same colour, indistinguishable from one another unless placed side by side.

very slightly, lighter than that of the men, but this had no reference whatever to the moieties, and in all other tribes there was no difference. One has to be very careful in regard to questions of colour because, for example, women in mourning plaster themselves all over with pipe clay, whilst men are continually decorating themselves with charcoal, pipe clay or red and yellow ochre. So far as children are concerned I could find no difference whatever. Every child at birth is copper-coloured, but in the course of a few days the skin darkens and assumes the chocolate brown of the adult.

The only way in which to judge accurately of the true colour of the skin is to cut a small square in a piece of white paper and then compare this isolated patch with a series of standard tints, such as are given in Broca's "Instructions Anthropologiques Générales." Casual observations of writers who say that they have noticed variations in the colour of various aboriginals are absolutely of no value and moreover are very misleading. Bunce's statement, quoted above, that "there exists a vast difference of complexion in the different individuals comprising the various tribes" is a typical example, and also a most extraordinary one. It is a very careless, rash conclusion, formed by a man with no idea of the need of scientific precision, but one who would usually be described as a "highly intelligent observer"—a most dangerous individual, at least so far as anthropology is concerned.

The "Blood and Shade" theory assumes that one moiety is, or was, originally dark, the other lighter, and that, whatever these physical differences may be between the two moieties, they are restricted, respectively, to the members of each of the latter. This raises an insuperable difficulty from a biological point of view, when it is remembered that in some tribes' descent is counted in the female, and in others in the male line. In a female descent tribe the children of a "dark-blooded" father, according to this theory, will all be "light-blooded"; in a male descent tribe they will all be "dark-blooded." That is, the father or mother, as the case may be, hands on, without exception, and exclusively, his or her dark or light blood, curly or straight hair, or, in the Melanesian peoples, as described by Dr. Rivers, his or her mental characters to all of his or her children. To put it otherwise, in the case of a dark-blooded brother and sister: in a male descent tribe all the children of the former will be "dark-blooded," and all those of the latter will be "light-blooded";

in a female descent tribe all the children of the brother will be "light-blooded," and all those of his sister "dark-blooded."

It is difficult to form any theory as to what the aboriginal really means by this differentiation of "shade" and "blood," so far as actual colour is concerned, and yet the idea is so widely spread that there must be something behind it, though this, I feel sure, has nothing to do with actual "colour" or "shade," in regard to which there is no difference so far as the members of different moieties are concerned. In connection with this I was much struck with the fact, when minutely examining one day twenty men of the Arunta tribe, representing both moieties and all sub-classes, that not only was I myself unable to detect any difference in colour amongst them, but the natives themselves were equally unable to do so.

After a very careful, long and close examination of natives belonging to many tribes from Lake Eyre in the south across the continent to Darwin in the north, and in the Territory from Daly River on the west to the Gulf of Carpentaria on the east, my experience has been that, though there are great variations in physical measurements, yet, on the other hand, so far as colour is concerned, there is an extraordinary uniformity, and no indication whatever, physically or mentally, of the union of two distinct races, such as is assumed to have taken place by various writers. The extraordinary variations in regard to physical structure, customs, beliefs and arts of Australian aboriginals cannot possibly be accounted for, or explained by such a theory.

[Proc. Roy. Soc. Victoria, 34 (N.S Pt. I., 1921].

Art. II.—*The Age of the Ironstone Beds of the Mornington Peninsula, as adduced from the Marine Fauna.**

By FREDERICK CHAPMAN, A.L.S., F.R.M.S.
(Palaeontologist to the National Museum, and Lecturer on Palaeontology, Melbourne University.)

[Read 14th April, 1921.]

The Related Tertiary Beds.

This peninsula is bounded on the west by Port Phillip Bay and on the east by Western Port. Owing to the dissection of this area by faulting, and also through the complication of its earlier structural features by local flows of basalt of the Older Period, which partially obscures an undeveloped river system of Miocene times, the geological succession of the various Tertiary beds are here difficult to make out in true detail.

As regards the position of the Grice's Creek and Balcombe Bay fossiliferous marine marls, these fail into line with beds in other areas, as at Muddy Creek (lower series) and the lower beds in the Altona Bay coal-shaft and the Sorrento Bore, all of which are of Oligocene (Balcombian) age, and therefore are at the base of the Tertiary system as developed in south-eastern Australia.

But between these Balcombian and the Kalimnan beds of the peninsula there should occur a series representative of the great diastrophic movements on sea and land during the Miocene period. The question arises: Have these beds been recognised? In reply to this it may be remarked that geologists have for many years been feeling their way to some kind of conclusion which has a more or less direct reference to the subject matter of this note, without reaching a definite conclusion—hence this present attempt.

Earlier References to the Intermediate Series.

A. E. Kitson (1900), in his "Report on the Coastline and Adjacent Country between Frankston, Mornington and Dromana,"[1] shows, in his accompanying map, the widely spread

* Read at the Hobart Meeting of the Aust. Assoc. Adv. Sc., held in Melbourne, Jan., 1921.

1. Monthly Progress Rep. Geol. Surv. Vict., N.S. No. 12, 1900, p. 12.

nature of the deposit of ferruginous grits, sands and clays, to which the fossiliferous ironstone undoubtedly belongs. He remarks upon them as follows:—

"Eocene (?).—Forming the surface along the coast-line from Frankston to a little below the mouth of Chechingurk Creek, and extending far into the country at the back are thick deposits of fine and coarse ferruginous and non-ferruginous sands, quartz grits and clays. On the coast they show in high and low cliffs and sloping banks, extend well up the flanks of the granite and Silurian[2] areas of Mounts Eliza and Martha, and stretch far out across the less elevated portions of the district."

. . . . .

"Until the fossils from the new beds herein mentioned, or other beds that may yet be discovered, are thoroughly examined and worked out, it is impossible to say definitely if all these strata are Eocene; but, lithologically and stratigraphically considered, the ferruginous and other beds overlying the fossiliferous Eocene clays may reasonably be referred to a much earlier period than the Pliocene, the age to which they have hitherto been assigned by the Survey."

"In some places there appears to be a distinct unconformity between these ferruginous beds and the fossiliferous clays, and in others no such break is noticeable with certainty. . . . They probably belong to the same series that extends along the coast northwards through Beaumaris and Brighton to Melbourne, and which, on the evidence of the Beaumaris beds, are regarded by Messrs. Tate and Dennant as of Oligocene age, and by Messrs. Hall and Pritchard as of Miocene age." . . .

"The determination of the casts of fossils, which no doubt exist in many other places besides those noticed, will probably prove of more material assistance eventually in this respect than any attempt made on stratigraphical evidence."

In the light of later discoveries of fossils, mentioned in the sequel, not only from Landslip Point, but also from Watson's Creek, near Baxter, and which was to some extent predicted and their value as horizon determinants emphasised as above, by Mr. Kitson, the "(?) Eocene" is now relegated to the Miocene or Janjukian.

The deposition of these beds against sloping banks and sometimes at angles up to 10° seems to point to shore or marine littoral conditions. That these ferruginous beds are older than

2. = Lower Ordovician.

the Beaumaris and Brighton series is proved by the faunal aspect of the fossil casts; and so they underlie the Kalimnan to the north.

Kitson's observations as to the ferruginous beds invariably overlying the fossiliferous clays (Balcombian) are valuable, as that alone fixes their approximate position in the Tertiary series. And lastly, the prediction that fossil evidence rather than the stratigraphical may settle the vexed question as to age and succession can be regarded as prophetic.

T. S. Hall and G. B. Pritchard (1901) in their paper on "Some Sections Illustrating Geological Structure of the Country about Mornington"[3] refer to the ferruginous grits as follows:—

"Ferruginous sands and clays mantle over a great part of the area, and their age is shown to be Eocene[4] by the fossils obtained at Landslip Point. It is, of course, quite within the bounds of possibility that further investigation may show that some of the beds are younger than this; but, in the meantime, we seem justified in referring the ferruginous grits of the district all to the one age."

An interesting point is here revealed, insomuch as the above authors, believing that some of the ferruginous beds may be younger than the "Eocene," thus gave additional proof, now that they prove to be Janjukian, from field evidence, that the Janjukian overlies the Balcombian, since the ferruginous grits and accompanying fossils are superposed on the Balcombian marls.

Messrs. Hall and Pritchard also furnished a list of fossils from Landslip Point, Frankston, which is as follows[5]:—

Placunanomia sella, Tate; *Pecten dichotomalis,* Tate; *Amussium zitteli,* Hutton sp.; *Lima bassi,* T. Woods; *L. linguliformis,* Tate; *Spondylus pseudoradula,* McCoy; *Septifer fenestratus,* Tate; *Nucula obliqua,* Lamarck; *Leda vagans,* Tate; *Glycimeris maccoyi,* Johnston sp.; *Arca (Barbatia) celleporacea,* Tate sp.; *Cucullaea corioensis,* McCoy; *Cardita delicatula,* Tate; *Chama lamellifera,* T. Woods; *Cardium hemimeris,* Tate; *Venus (Chione) cainozoicus,* T. Woods sp.; *Corbula pyxidata,*

3. Proc. Roy. Soc. Vict., Vol. xiv. (N.S.), pt. i., 1901, p. 44,

4. The Landslip Point Fossils were later shown to be of Janjukian or Miocene age. See Chapman, Mem. Nat. Mus., Melbourne, No. 5, 1914, pp. 29, 30.

5. Proc. R. Soc. Vict., Vol. xiv. (N.S.), pt. i., 1901, pp. 46-53, The nomenclature is here corrected to date.

Tate; *Argobuccinum pratti,* Tate sp.; *Lotorium tortirostre,* Tate sp.; *Nassa tatei,* T. Woods; *Lyria harpularia,* Tate; *Marginella propinqua,* Tate; *M. wentworthi,* T. Woods; *Turris* (?)*trilirata,* Harris sp.; *Bathytoma rhomboidalis,* T. Woods sp.; *Bela* (*Daphnobela*) *gracillima,* T. Woods sp.; *Conus cuspidatus,* Tate; *Cypraea subpyrulata,* Tate; *Trivia avellanoides,* McCoy; *Natica hamiltonensis,* T. Woods; *Solarium acutum,* T. Woods; *Turritella murrayana,* Tate; *Siliquaria occlusa,* T. Woods sp.; *Scaphander tenuis,* Harris; *Vaginella eligmostoma,* Tate; *Dentalium aratum,* Tate.

The above list does not seem to include any species which are distinctive of either Balcombian or Janjukian, for they all have an extensive geological range.[6]

A further suite of fossils was recorded from the ironstone band at Landslip Point by the present writer in 1914,[7] the result of an extended search made by Mr. R. A. Keble and himself. These fossils are:—

Placotrochus sp.; *Sphenotrochus emarciatus,* Duncan; *Ditrupa cornea,* L. sp., var. *wormbetiensis,* McCoy; *Terebratula* (?)*aldingae,* Tate; *Magellania garibaldiana,* Davidson sp.; *Pecten foulcheri,* T. Woods; *P.* cf. *flindersi,* Tate; *P. praecursor,* Chapman; *Limatula* sp.; *Cuspidaria subrostrata,* Tate; *Dentalium mantelli,* Zittel; *Latirus* (?)*actinostephes,* Tate sp.; *Oliva* sp.; *Columbarium acanthostephes,* Tate sp.

Among the above fossils, *Ditrupa cornea,* var. *wormbetiensis* is especially typical of Janjukian beds. *Terebratula aldingae* is a restricted Janjukian form, as are also *Pecten praecursor* and *P. flindersi.*

The writer has also (loc. supra cit.) compared these ferruginous gravels with the "older gold drifts" in Western Victoria, where, at Stawell,[8] they contain a fairly extensive series of Janjukian marine fossils.

6. See F. Chapman, Mem. Nat. Mus. Melbourne, No. 5, 1914, p. 29, par. 3.
7. Loc. supra cit., pp. 29, 30.
8. Vict. Naturalist, Vol. xxi., 1905, pp. 178-180.

Further Evidence of the Miocene Age of the Ferruginous Deposits.

A few months ago my friend, Mr. J. H. Young, of Meredith, who is already known as an enthusiastic and successful collector of fossils, paid a visit to Watson's Creek, near the intersection of the Pearcedale and Somerville Roads, half a mile west of Baxter railway station. He there found an ironstone band crossing the creek, which contained fossil casts. Several clearly identifiable specimens of *Pecten praecursor* were found there, a species which is typical of the Janjukian. The matrix in which the fossils occur is a fine-grained ironstone, with small patches of limonite, minute flakes of micaceous iron-ore, and also small, numerous wind-polished quartz grains scattered throughout. Besides the Pectens there are numbers of small fragments of polyzoa present, but indeterminable. These polyzoa are in such abundance as to lead one to infer that the ironstone is largely a replacement of a limestone comparable with the polyzoal rock of Batesford and Grange Burn. This replacement at a later stage, of calcareous by limonitic material seems precisely similar to what has happened in some of the "Gold Drifts" as at Stawell, referred to above, which are to some extent re-sorted or remanié beds, the same characters being also borne by certain of the ferruginous beds of the Mornington Peninsula.

Conclusions.

(1) The lower part of the ferruginous series of sandstone and fossiliferous ironstone on the Mornington Peninsula from Frankston southwards is without doubt of Janjukian (Miocene) age.

(2) The fossiliferous ironstone appears to have originated from a more decidedly calcareous rock, and in some cases equivalent to a polyzoal limestone in its included fossils and original chemical composition.

(3) The change from limestone to ironstone has in some cases been brought about by a percolation of dissolved carbonate of iron, causing an interchange of bases, the replaced carbonate of iron afterwards becoming oxidised.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. I., 1921].

Art. III.—*The Specific Name of the Australian Aturia and its Distribution.*

By FREDERICK CHAPMAN, A.L.S.
(Palaeontologist to the National Museum, and Lecturer on Palaeontology at the Melbourne University.)

(With Text Figure.)

[Read 12th May, 1921].

The Specific Name.

The unrivalled experience and wide acquaintance of the Tertiary mollusca which my friend, Mr. R. Bullen Newton, possesses would naturally forbid me to question his decision that the Australian *Aturia australis* is identical with the European *Aturia aturi,* had it not happened that already I have shown,[1] at least to my own satisfaction, that the species are entirely distinct.

Mr. Newton has recently published[2] an account of a sandstone cast of an *Aturia* from Western Australia, lately acquired by the British Museum, and bases upon this and a comparison of presumably the two specimens recorded from the British Museum collection,[3] a conclusion as to their identity. The differences between these forms, the Australian and the European, I have already pointed out,[4] though this seems to have been overlooked by Mr. Newton. These differences are as follows:—

"(1) The Australian shells are more compressed.

(2) The septa and growth-lines are more strongly recurved towards the periphery.

(3) The siphuncular orifice is larger."[5]

In the same paper I also remarked as follows:—

"In view of the above-named characters, which are constant so far as my own observations go, there are justifiable grounds for keeping the Australian form as a distinct species, at the same time bearing in mind that its relationship is nearest *Aturia aturi.* . . . Probably did the London Museum [British]

1. Proc. R. Soc. Vict., Vol. xxvii. (N.S.), pt. ii., 1915, pp. 350-353, pl. iii., figs. 1, 2.
2. Proc. Malac. Soc., Vol. xiii., Oct., 1919, pp. 160-167, pl. v.
3. Cat. Foss. Cephalopoda, Brit. Mus., pt. ii., 1891, p. 355.
4. Loc. supra cit., p. 352.
5. I find, however, that this is not an invariable character.

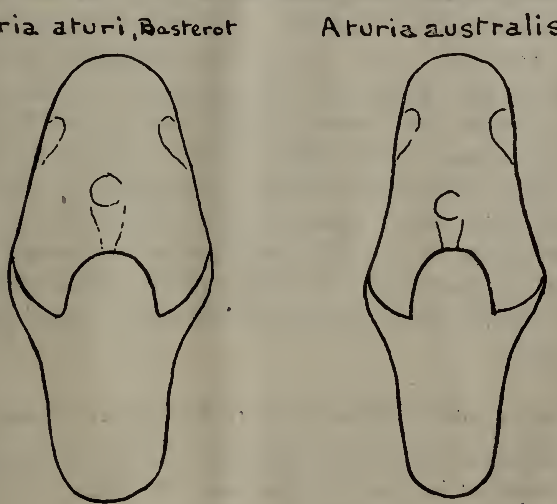
possess a larger comparative series of the Australian form, that view[6] might undergo some modification, and it is to be regretted that Mr. Newton did not have time to critically examine the series of *Aturia* in the Melbourne National Museum."

From a re-examination of the Australian examples I am satisfied that the forms are perfectly distinct, the compressed sides and the generally narrower shell being marked characters of Balcombian, Janjukian and Kalimnan specimens. This feature of the compressed shell is very characteristic of all the southern specimens so far as I have seen, and in some specimens it is developed to an extreme degree. On the other hand the European *A. aturi* tends towards obesity, and an extreme example of this is figured by Bronn.[7]

Hypothesis of Type Origin.

From the preceding note of the variations seen in the southern and northern forms it is highly probable that the early (? Lower Oligocene or even Eocene[8]) shells which were ancestral to

ORAL ASPECT OF NORTHERN AND SOUTHERN TYPES.



6. Newton and Cricks' agreement as to the identity of the two forms.
7. Lethaea Geognostica, Vol. iii., and pl. xlii., figs. 17a-c.
8. This earlier stage is suggested on account of the occurrence of large and well-developed shells in the Balcombian of Muddy Creek, one example, found by my son, W. D. Chapman, and now in the National Museum, having a diameter of nearly seven inches.

the already discovered fossils were intermediate in character, and originated in moderately low latitudes, in the Indian Ocean geosynclinal area. The southern form probably radiating to Patagonia, Australia and New Zealand, exhibits variants of compression, whilst that found in Europe tends to inflation. Further data bearing on this hypothesis are furnished in regard to the ratio of shell measurement—umbilical width to diameter. For example, one of the oldest Australian specimens gave a ratio of 1 : 2.91, as against the Bordeaux specimen, 1.2.2; whilst a younger (Janjukian) specimen from Torquay, Victoria gave 1 : 3.26. The Kalimnan specimens are too fragmentary to measure, but bear out this gradually decreasing width ratio.

Distribution of Aturia australis.

Mr. Newton has already given copious notes of the distribution of this fossil in the paper referred to, and it will therefore be unnecessary to repeat them *in extenso*. In New Zealand, we may remark in passing, that *Aturia australis,* though common in the Lower Oamaruian, dies out before the upper beds (Awamoan) are reached. Its geological range in that area seems indeed to be restricted, as was that of *Aturia aturi* in France, Egypt, and elsewhere. Mr. Newton has suggested that the Southern Australian Tertiaries (Balcombian, Janjukian and Kalimnan) represent the Lower, Middle and Upper Miocene, having regard, amongst other data, to the co-extensive range of *Aturia* therein. There are perhaps some points in favour of linking up the lower beds, seeing that at Muddy Creek (Balcombian), both large and small *Lepidocyclinae* are found associated together, as they also are at Batesford (Janjukian), but the evidence requires more support to warrant a re-adjustment of the time-scale.

Comparisons and Limitations of European Stages.

On the evidence derived from a study of the larger Foraminifera, the Balcombian is clearly Aquitanian, so nearly as we can arrive at a correlation of distant sediments. This stage was included by Meyer-Eymar[9] in the Upper Oligocene. Since then Dollfus has favoured the inclusion of the Aquitanian in the

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9. Classification des Terrains tertiaires, 1884 { Aquitanien Upper; Tongrien Middle; Ligurien Lower } Oligocene.

Miocene.[10] The American geologists, Osborne[11] and Chamberlin, as well as Deperet,[12] advocate the position of the Aquitanian as Upper Oligocene. Mainly from the occurrence of the Foraminifera, H. Douville and F. Sacco have in their numerous papers before the Geological Society of France, regarded the large discoidal *Lepidocyclinae* as of Aquitanian age, and the smaller forms of Burdigalian. The genus itself they limit to the Miocene, and therefore they regard Aquitanian as Lower Miocene. Haug, in his studies of geosynclinals also supports these views, regarding the northern Miocene period as one diastrophic whole. We may still hold to the view, however, that great crustal movements did not commence synchronously at the Antipodes.

The sequence of the Lower Tertiary beds in Southern Australia is very gradual, and the sedimentation in one area at least, as shown by the cores from the Sorrento Bore, was never interrupted in that area, but was continuously marine. On the other hand there is a marked unconformity between the Janjukian and Kalimnan, which plainly demonstrates a considerable time-break, and denoted usually by a nodule bed, and we are perforced to mark its distinction from the Miocene as a whole, although, as in *Aturia,* some species range through to the basement Kalimnan.

Referring to the suggestion that the Kalimnan series of Victoria represents the Upper Miocene (Messinian or Pontian)[13] of Europe, by an argument based on the occurrence of *Scaldicetus,* this idea is almost nullified by the fact that this cetacean genus has been lately discovered anew[14] in the Balcombian beds of Muddy Creek (*Scaldicetus lodgei*). Further than this, the presence of the Miocene sharks' teeth in the Kalimnan is accounted for by their occurrence in the basal bed which is often remanié in character.

Summary of Argument.

The writer finds no evidence to justify the identification of *Aturia aturi,* Basterot, with *Aturia australis,* McCoy, and from

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10. See "L'Aquitanien en Aquitania," Bull. Soc. Geol. France, ser. 4, vol. xii., 1912, p. 472.
11. The Age of Mammals, 1919, p. 224.
12. Transformations of the Animal World. Inter. Sci. Ser., 1909, Table.
13. Newton, Loc. cit., p. 166.
14. Proc. Roy. Soc. Vict., Vol. xxx. (N.S.), pt. i., 1917, p. 34, pl. iv., fig. 6.

a renewed examination concludes that they have distinctive characters of their own which must be regarded as specific.

The suggestion that the Balcombian to Kalimnan Tertiary beds of Southern Australia comprise one period, the Miocene, seems to be untenable from the fact that the succession above the Kalimnan passes upward in sequence, and a new arrangement would mean either an unconformity or the intercalation of a new horizon between the Kalimnan and the Werrikooian to include a Lower Pliocene horizon, which speaking faunistically, is not possible.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. I., 1921].

Art. IV.—*Notes on Amycterides, with Descriptions of New Species, Part III.*

By EUSTACE W. FERGUSON, M.B., Ch.M.

[Read 12th May, 1921]

The following paper contains the descriptions of a few species that have been discovered within recent years. Most of the new species belong to the genus *Sclerorinus;* the members of this genus are often exceedingly difficult of identification, as many, particularly those belonging to Section I., run extremely close to each other, and a knowledge of both sexes is absolutely essential in many cases for identification. For this reason several species represented in my collection by the female sex only are left undescribed.

Within the last two years the veteran entomologist, Dr. David Sharp, has turned his attention to the Amycterides, and is now working on the subdivision of the larger groups, such as *Phalidura, Talaurinus* and *Sclerorinus,* into smaller genera, according to the structure of the male genitalia. One paper has already been published (Entomologists' Monthly Magazine, third series, vol. vi., Jan., 1920, pp. 1-7) dealing with the genera constituting what Dr. Sharp characterises as the tribe *Phaladurines.* This tribe contains the old genus, *Phalidura (Psalidura),* subdivided by Dr. Sharp into *Phalidura* and *Aphalidura,* a new genus—*Prophalidura*—of which *Talaurinus riverinae* is the type, and *Eustatius,* formed for a new species *E. fergusoni.* A table is given of the relation to each other of these four genera. As the change of names affects many Victorian species a few comments may not be out of place.

Phalidura. Genotype—*P. reticulata,* Boisd. (= *P. mirabilis* (Macleay) Fischer, nec Kirby). In the name of this genus Dr. Sharp has revived the original and certainly correct spelling in preference to the emendation *Psalidura* made by Erickson (Agassiz Nomencl. Zool. Col., p. 136), and not by Gemminger and Harold, as stated by Dr. Sharp. In this revival of the name *Phalidura* I am absolutely in accord with Dr. Sharp. Under the genus as defined by Dr. Sharp are included groups

1 and 2 of my revision, and, according to Dr. Sharp, probably most of the other species as far as group 6.

Aphalidura. Genotype—A. *impressa*, Boisd. Included with this are *P. sloanei,* Ferg., and *P. breviformis,* Ferg.. *P. sloanei,* Ferg., is certainly congeneric with *P. impressa,* Boisd., and if the genus *Aphalidura* is to be recognised all the members of group 7 should be included. I am much more doubtful about the species of group 9, of which *P. breviformis,* Ferg., is a member, and there seem equally good reasons for separating all the groups generically as for splitting off groups 7 and 9. For the present, therefore, and until much more work is done on the male genitalia and abdominal segments of the various groups, I think it would be better to restrict the new genus to group 7. For this reason, in describing a new species of group 9 in the present paper, I have thought it better to place it under the old genus *Phalidura.*

A further difficulty arises in connection with the name of the genus. *Phalidura impressa,* Boisd., the type of *Aphalidura,* is almost certainly the original *Curculio mirabilis,* Kirby, or as Sharp says, possibly a close ally of it. The key to the solution lies in the interpretation of the figure of the male sexual mechanism given by Kirby. As Dr. Sharp points out, the figure is not satisfactory for *P. impressa,* though the discrepancies may be partially, if not wholly, due to foreshortening. I believe that this is probably the case as in all the allied species known to me the apices of the laminæ are broadly rounded, and not obtusely pointed as in *P. impressa,* and in the figure of *C. mirabilis.*

I have to thank Mr. Sloane for drawing my attention to the fact that Erickson, as early as 1842 (Archiv. fur Natur., p. 113) identified *P. mirabilis,* Kirby, with the only known Tasmanian species, and in a footnote gives *A. mirabundus,* Gyll., as a synonym, while drawing attention to (?)Schönherr's misidentification of *P. mirabilis. A. mirabundus,* Gyll. (1834) antedates *A. impressus,* Boisd. (1835), the type of which was also from Tasmania.

If *Curculio mirabilis,* Kirby, is to be thus identified with *Amycterus impressus,* Boisd., the further question arises as to whether the name *Amycterus* should not be used in preference to *Aphalidura* for this group. *Amycterus* was described in Schönherr's *Curculionidum Dispositio Methodica,* 1826, p. 202, the type of the genus being given as follows:—

Typus: *Curc. mirabilis,* Kirby, in Linn. Trans.—Species unica e nova Hollandia, magna, facie aliena, rostri forma insolita et valde singulari.

This absolutely fixes the name *Amycterus* to the species described by Kirby, and is not affected by the fact that Gyllenhal, in 1834, in re-describing, from the Schönherr collection, *Amycterus mirabilis,* described the gular-horned species previously described by Fischer (1823) as *Phalidura mirabilis* (= *P. reticulata,* Boisd.).

If, therefore, group 7 is to be separated generically from *Phalidura,* the name *Amycterus,* which I have, in an earlier paper, placed as a synonym of *Phalidura,* must be revived and used in preference to *Aphalidura,* Sharp.

I have gone into this question at some length, as the change of names will affect most of the Victorian species now called *Psalidura.*

Prophalidura. The type species is *Talaurinus riverinae,* Macl., and a second species, *P. truncata,* is described. This I have not been able to identify. The limits of the genus are somewhat uncertain, but, as characterised, would probably exclude many species such as *tomentosus, howitti, maculipennis,* etc., which show a decided resemblance to *riverinae.* One species,—*T. granulatus,* Ferg.—should, I think, be referred to *Prophalidura.*

Eustatius fergusoni, Sharp. Both genus and species are unknown to me; it is probably a good genus, but the distinction as regards the short forceps is hardly sufficient to separate it from *Phalidura,* as equally short forceps occur in several species of that genus.

Boisduvalian Types of Amycterides.

In a previous paper (Proc. Linn. Soc., N.S. Wales, 1911, xxxvi., p. 141), I re-described such of Boisduval's types of Amycterides as were in the Dejean collection, now in the Brussels Museum. A few types described from other collections were not seen, and while in Paris I endeavoured to trace the whereabouts of these, and in particular of those belonging to the collection Dupont. In the Museum National d'Histoire Naturelle at Paris I examined the types of *Talaurinus tomentosus,* Boisd., and *Euomus scorpio,* Boisd., both of which are correctly identified in Australian collections.

A specimen of *Acantholophus aureolus*, Bohem., in the museum, was marked as the type of *Acantholophus echinatus*, but whether it is the type of Guerin's or Boisduval's species of that name I am uncertain. The question is fully discussed elsewhere; it is to be noted, however, that none of the types of other species described by Guerin are in the Museum.

At the time I could get no certain information in regard to the types from the Dupont collection, but later received a letter from M. Lesne, of the Museum, from which the following passage is quoted:—

"Pour ce qui est de la collection Dupont, mes souvenirs étaient inexacts. Les Curculionides de cette collection avaient été cédés à Jekel. Ils sont passés ensuite dans la collection Bowring qui est conservé aujourd'hui au British Museum."

On receipt of this information I wrote to Mr. G. F. Arrow, of the British Museum, and received the following reply: "We had no idea any of Boisduval's weevils were in our collection, but have found specimens with "Dup." in Jekel's writing, so no doubt Lesne is right. Jekel seems to have systematically removed all original labels, replacing them only with a number, of which we have no explanation. There are Bowring specimens of *rugifer*, *basalis*, etc., which are very likely types, but I can find no positive evidence in any case. As it is more than 50 years since the Bowring collection came here it is likely that some specimens have been parted with, or even destroyed as worthless."

The species affected are as follow, placed in their proper genera: *Talaurinus rugifer*, *Sclerorinus tristis*, *Macramycterus boisduvalii*, *Mythites basalis*, and the species described as *Amycterus posticus*, which I am not able to place generically. With the exception of the last, the names of these species have been attached to well known species, which agree very well with the original descriptions.

Types of Amycterides in the British Museum.

While in London I was able to examine the types of Amycterides contained in the British Museum collection. Notes on some of these have already been given, or they will be dealt with in their places in the revision of the subfamily, this in particular applying to the Euomid genera.

The following notes may be recorded here:—

Talaurinus phrynos, Pasc.—This is certainly a female *Phalidura,* and practically certainly the female of *P. forficulata,* Macl., from the same locality—Rockhampton.

Talaurinus victor, Pasc.—The type is a female of T. *caviceps,* Macl.

Talaurinus carbonarius, Pasc.—Good species; type is a female.

Talaurinus inaequalis, Blackb. and *Talaurinus strangulatus,* Blackb. Closely allied species, differing in the more excavate rostrum of *T. strangulatus.*

Talaurinus pustulatus, Pasc.—The common Western Australian species—*T. semispinosus,* Bohem.

Talaurinus simulator, Pasc.—Type a ♂, with more acute tubercles than in the specimens identified by Blair. Unfortunately none of these specimens were available for comparison, but I think that probably they are correctly placed.

Sclerorinus echinops, Pasc.—As previously recorded (These Proceedings, 1915, p. 243), this species belongs to Talaurinus (sens. lat.), and is closely allied to *T. semispinosus,* but a distinct species; type is a female.

Talaurinus funereus, Pasc.—Type appears to be a somewhat abnormal female of *T. roei,* Bohem, with tubercles rather obsolete at base, and fewer than usual.

Talaurinus lemmus, Pasc. *(Pseudonotonophes).*—The head of type is non-granulate.

Talaurinus pupa, Pasc. *(Pseudonotonophes).*—The head of type is distinctly granulate. This species is the same as *P. dumosus,* Macl.

Sclerorinus molossus, Pasc.—Type is a female; tubercles black, otherwise the same as specimens so identified in my own collection.

Sclerorinus molestus, Pasc.—Considerable variation exists among specimens referred to this species; the following brief notes made on the type are therefore reproduced: "Type ♂. Ventral vitta tawny. Prothorax broadly dilatate, set with small, rather depressed granules, with granules on sides much smaller and obsolete towards coxæ. Elytra with granules small, equal in size on all the rows, 5, 16, 5, 16, 14 in number on the interstices of left side.

Sclerorinus taeniatus, Pasc.—Type is a male, and the same as *S. stewarti,* Macl.

Opetiopteryx frigida, Blackb.—Vide infra.

Portion of the Amycterides of the Hope Collection (Oxford) were at the British Museum, and I was able to examine the types of the following species:—

Acantholophus hystrix, Bohem.—As identified in Australia.

Hyborrhynchus coenosus, Bohem.—As identified in Australia ♀.

Cubicorrhynchus bohemanni, Bohem.—As identified in Australia ♀.

Cubicorrhynchus scotobioides, Hope M.S.=*C. bohemanni* ♂

Talaurinus westwoodi, Bohem.= *T. bucephalus,* Oliv.

Talaurinus gyllenhalli, Hope M.S.= *T. bucephalus,* Oliv.

Talaurinus excavatus, Bohem.= *T. rugifer,* Boisd.

Talaurinus semispinosus, Bohem.—As identified in Australia.

Talaurinus pastillarius, Bohem.= *T. semispinosus,* Bohem. It is doubtful whether this specimen is the type.

Talaurinus roei, Bohem.—*T. funereus,* Pasc. is a synonym.

Sclerorrhinella manglesi, Bohem.—As identified in Australia.

Opetiopteryx frigida, Blackb.

Blackburn, Proc. Linn. Soc. N.S. Wales, vii., 1892, pp. 125, 126.

I am unable to follow Blackburn in placing this species among the Amycterides. The general facies is much more like *Polyphrades,* and the shape of the rostrum and scrobes quite unlike any Amycterid. The tarsal joints are much more expanded than in any Amycterid known to me, and the funicle is 7-jointed.

The species must be rejected from the Amycterides, but its position is doubtful. Possibly it is allied to *Bothynorrhynchus,* which was placed by Lacordaire in the Somatodides.

Phalidura affinis, n.sp.

Closely allied to *P. elongata,* Macl., but with more widely separated fascicles.

♂ Black; moderately densely clothed with minute yellowish-brown subpubescence, feebly variegate with grey; setæ yellowish-brown.

Head and rostrum as in *P. elongata;* the internal dorsal rostral ridges slightly more prominent, and the median area feebly carinate. Prothorax and elytra as in *P. elongata,* except that the intrastrial granules on the elytra are less evident.

Venter as in *P. elongata;* the apical excavation of the same shape, but with the fascicles slightly larger, and distinctly farther apart. Forceps apparently slightly shorter, the laminæ similar in shape.

Dimensions.—♂ 22×8 mm.

Hab.—Queensland. Type in Queensland Museum. This species might be better regarded as a geographical race, or subspecies of *P. elongata.* The three males before me all agree in the shape and position of the fascicles, which are constantly wider apart than in *P. elongata.* I have seen numerous examples of the latter species, and they all agree in the closely approximated fascicles. It seems to me, therefore, that the Queensland form is worthy of a distinguishing name. No locality labels are present on the specimens.

Associated with the three males are seven females, which probably belong to the same species, but the lack of locality labels does not permit of absolute certainty, as the females of several allied species are practically indistinguishable.

Phalidura hopsoni, n.sp.

Allied to *P. variolosa* and *P. irrasa,* but differing in the genitalia of the male.

♂ Black, sparsely clothed in depressions, with minute greyish subpubescence; setæ dark.

Head convex, setigeropunctate; with a median, longitudinal impression anteriorly. Rostrum about as wide as head, width across external ridges about one-half the total width; upper surface deeply excavate anteriorly, with basal foveæ narrow, triangular but deep, and a median fovea separating the ends of the internal ridges. Eyes ovate, rather larger and less deeply set than in *P. irrasa.* Antennæ with scape shorter and somewhat stouter than in *P. irrasa.*

Prothorax as in *P. variolosa;* set with similar setigerous granules; median impression most distinct posteriorly.

Elytra as in *P. variolosa;* punctures open foveiform; interstices set with small setigerous granules, in single series, duplicated on the third and fifth interstices.

Apical ventral excavation deep, praeanal fossa not very sharply marked off from rest of excavation; fascicles black, rather widely separated; apical margin with a fringe of black bristles, closely set with an intermediate row of similar bristles, so that the two rows are hardly separable. Forceps short, stout at base, ending in an obtuse point, apices not meeting; laminæ more strongly convex, and less elongate than in *P. irrasa* and *P. variolosa,* more or less concealed by a thick brush of hairs projecting between the bases of the forceps, and apparently arising from the last dorsal segment.

♀ Resembles the females of the allied species, but antennal scape shorter.

Dimensions.—♂ 17×8 mm.—14.5×6 mm.; ♀ 15×6 mm.

Hab.—New South Wales, Barrington Tops (H. J. Carter), Eccleston (J. Hopson).

The genitalia is similar to that of *P. variolosa* and *P. irrasa,* but differs from both in some features. The bristles on what I have previously termed the intermediate row, and on the apical margin, are closely applied, and difficult to distinguish from one another; they are obviously shorter than in *P. variolosa* and *P. irrasa,* and apparently both sets cross the middle line. The bristles on the last dorsal segment form a very conspicuous brush, projecting between the blades of the forceps, which are shorter, and do not meet at the apex. Type in author's collection.

Talaurinus anthracoides, n.sp.

♀ Allied to *T. tenebricosus,* Ferg., but larger, with rougher sculpture.

Black, practically destitute of clothing; setæ black.

Head convex, rather feebly depressed in front at base of rostrum; eyes small, rotundate. Rostrum short, almost as wide as head; external margins raised into subparallel ridges, running back to head, but not continued along forehead, moderately closely setigero-punctate; upper surface excavate, internal ridges distinct, little convergent, sublateral and basal foveæ forming a horse-shoe shaped impression at base. Antennæ moderately long, scape stout, funicle with joints short, the first somewhat longer than the second.

Prothorax rounded on sides, widest in front of middle, apex with median and ocular lobes widely rounded and little prominent; disc convex, without impressions, closely set with small, round, subcontiguous granules; sides also granulate.

Elytra evenly rounded on sides, apex hardly produced, widely rounded; base feebly emarginate, humeral angles with a small nodule; disc with punctures rather large, open, not distinctly separated from one another; interstices hardly raised, closely set with small round setigerous granules, in single series, occasionally duplicated in middle of third and fifth, and extending down declivity; sides granulate. Venter convex; apical segment with a median longitudinal impression in posterior half, with a transverse sulcus at extreme apex. Legs simple.

Dimensions.—♀ 17 × 7 mm.

Hab.—Victoria, Trawool, Kerrisdale (J. E. Dixon).

Described from three females received from Mr. J. E. Dixon. I have departed from my usual plan of describing only when the male is known, as in this case it does not seem likely to be confused with any other species.

I regard it as allied to *T. tenebricosus,* the rostral structure and general appearance are similar, but the present species is decidedly larger, and the granules much more evident. After the description of the female was written, and when the manuscript was practically complete, I received a somewhat broken specimen of the male, taken by Mr. Dixon in the same locality.

Allotype ♂.—Similar to female, apex subtruncate, with rather thick granulate flanges on each side, separated in the mid line by a small notch. Legs simple. Ventral segments flattened, the intermediate ones rather short, the apical strongly concave, deepest along the posterior margin; ventral surface of apical dorsal segment also concave; ends of forceps visible at sides of excavation. Dimensions.—♂ 16 × 6 mm.

I have endeavoured to dissect out the genitalia, but found that unfortunately most of the internal structures had disappeared. The eighth ventral segment was, however, represented by a pair of well developed strongly chitinised forceps, the apices of which project externally. The inner surface is curved inwards towards the base to form a strong process extending almost to the mid line, but apparently there is no fusion of the processes of the two blades, though, as this portion is broken, it is impossible to be sure, and it is likely that the gap was bridged by chitin, as there is a small mass adhering at one side. In the allied species *T. tenebricosus,* the forceps are very similar in shape, though smaller and the inner ends are connected by chitin, the segment furthermore possessing another flat plate of chitin anterior to the bar between the inner processes of the forceps;

there is however no vertical plate as in *Prophalidura,* and the species can hardly be placed in that genus as at present defined. If the characters of the eighth ventral segment are to be regarded as of generic value many new genera will be necessary, at present and until much more work can be done on the dissection of these species, I think it inadvisable to erect isolated genera, and prefer to place the species under *Talaurinus* in the Macleayan use of the genus.

NOTONOPHES DILATATICEPS, Blackb.

Cubicorrhynchus dilataticeps, Blackb., Report Horn Exped. Central Australia, ii., 1896, p. 293; Ferguson, Proc. Linn. Soc. N.S. Wales, 1914, xxxix., p. 224; *Notonophes auriger,* Ferg., loc. cit., p. 222.

In my revision of the genus Notonophes I referred *Cubicorrhynchus dilataticeps,* Blackb., there. I have since examined the type in the British Museum, and it is certainly a species of *Notonophes,* and evidently the same as *N. auriger,* Ferg., although a specimen of the latter was not available for comparison.

SCLERORRHINELLA CRAWSHAWI, sp. n.

Allied to *S. granuliceps,* Ferg., but larger, with smaller less regular granules.

♀ Black; densely clothed with fine white decumbent pubescence; head with a broad stripe of dark brown on each side of median line; prothorax with an ovate brown patch on disc, not reaching apex and bisected by a median white vitta, a fainter brown stripe at lateral margins; elytra with scattered, irregular, brown macules; venter more sparsely clothed, the basal segments practically without clothing except at sides; legs densely clothed with white.

Head convex, front somewhat flattened, and set with small, slightly depressed, separate granules, the vertex and sides not granulate. Rostrum short and broad; lateral margins not raised, slightly convergent to base, setigeropunctate; median area lævigate, trianguliform, depressed in front; basal sulci rather broad; internal ridges absent. Antennæ of moderate length, funicular joints short, the first longer than the second.

Prothorax evenly rounded on the sides; apical margin with rather feeble post-ocular sinuation; disc convex, closely set with small, round granules, smaller on median vitta, the granules completely clothed, and less conspicuous on the areas covered with white pubescence, but incompletely covered on the brownish clothed areas; sides granulate.

Elytra robust; apex widely rounded; base gently emarginate, humeral angles noduliform; strial punctures shallow, open, transverse; interstices little raised, set with very fine granules, more or less concealed by the clothing, somewhat variable in size, set in rather irregular single series, duplicated in places, absent on apical half of fourth interstice and on declivity; granules obsolete on lateral interstices. Venter convex, with fine scattered setigerous punctures. Legs simple.

Dimensions.— ♀ 17×7 mm.

Hab.—Western Australia, Jandakot (W. Crawshaw).

Three specimens of this fine species are before me, all females, but I have had no hesitation in describing the species, as it is quite distinct from the other known members of the genus. The species is apparently most closely allied to *S. granuliceps*, Ferg., but differs in the finer, less regularly arranged, granules on both prothorax and elytra. I have much pleasure in naming this species after its discoverer.

Type in author's collection.

Sclerorinus daveyi, n.sp.

♂ Moderately large, elongate. Black; moderately densely clothed with dark brown depressed pubescence; head and prothorax rather feebly trivittate, with lighter creamy clothing, elytra with feeble traces of light clothing about shoulders.

Head flattened in front, in the same plane as, and not separated from dorsal surface of rostrum. Rostrum with external margins parallel; median carina distinct, with a small puncture at junction with head; sublateral sulci broad, rather shallower than in *S. oblongatus*. Mandibles with inner edge produced apically into a somewhat obtuse point, variable in shape, or absent on one side.

Prothorax strongly rounded on the sides, apical margin with strong postocular lobes, and feeble median lobe; disc with subapical constriction moderately marked, and with median line shallowly but distinctly impressed; rather remotely set with elongate subobsolete setigerous granules, practically only distinct between median and sublateral vittæ; sides without granules.

Elytra elongate, subparallel; base gently emarginate; humeral angles subtruncate; disc with punctures open, shallow, not very distinct; interstices slightly raised, the third and fifth more so than the others; with slight tuberculiform elevations at irregular intervals, the second interstice with 5; the third with 8-9 indicated, the basal ones hardly more elevated than the interstice, which is here subcostiform, the apical ones small, granuliform, but more distinct, extending half-way down declivity; fourth with 3-4 small tubercles; fifth subcostiform the individual tubercles only indicated by setæ, somewhat more distinct posteriorly; sixth with a continuous row of small separate granuliform tubercles; seventh and lateral interstices with tubercles obsolete. Venter somewhat flattened along middle; apical segment with posterior margin strongly bisinuate, the median portion produced as a rounded lobe, somewhat depressed. The last dorsal with undersurface emarginate to correspond with projection of apical ventral segment. Legs not notched; anterior tarsal joints asymmetrical, but less markedly so than in some of the allied species.

♀ Agrees with male; elytra somewhat more ovate; venter convex, apical margin produced ventrally but not bisinuate, with a small emargination at extreme apex, filled with a few stout setæ.

Dimensions.—♂ 16×6 mm.; ♀ 16×6 mm.

Hab.—Victoria, Portland District (H. W. Davey and J. E. Dixon).

I am indebted to Mr. H. W. Davey for a series of this species.

A female given me by Mr. J. E. Dixon differs in being larger (17×8 mm.), and in the much lighter clothing; the head and prothorax are conspicuously trivittate with white, while the median line of elytra, and much of the lateral portions of the disc are covered with similarly coloured clothing. The sculpture is much as in the type, except that the tubercles are slightly larger; the apical ventral segment is lightly impressed in the median line, and the apex is as described.

S. daveyi belongs to a group of closely allied species, for whose correct determination a knowledge of both sexes is necessary; thus the present species is close to *S. inornatus,* from the ♂ of which it can only be distinguished by its less obliterate sculpture, whereas the two females are abundantly distinct.

SCLERORINUS SLOANEI, n.sp.

♂ Elongate, subparallel. Black; sparsely clothed with minute brown subpubescence; setæ dark brown.

Head convex, forehead somewhat flattened, in same plane with dorsal surface of rostrum; feebly longitudinally impressed on each side of median line, with two small linear foveæ in median line, one in centre, and one at junction with rostrum. Rostrum subparallel, the median carina as distinct as the external ridges, all three carried back on to head; sublateral sulci moderately broad, deeper at base. Antennæ comparatively short, moderately stout, first funicular joint longer than second.

Prothorax rounded on sides, broadest in front of middle; apical margin hardly produced above, feeble emarginate in middle, with fairly evident ocular lobes; subapical constriction moderately marked, median line lightly impressed; disc set with subdepressed, elongate, irregular sub-confluent granules, becoming smaller and more rounded at sides; lateral surfaces with small scattered obsolescent granules.

Elytra elongate, subparallel, apex rounded; base gently emarginate, humeral angles not tuberculate; with rows of small, well defined foveiform punctures, each subtended by a small seta; the first, third and fifth interstices raised, with elongate somewhat flattened tubercles, less elongate towards apex of elytra, with small setæ at the posterior end; second and fourth interstices neither raised nor tuberculate; sixth and seventh with less elongate tubercles; lateral interstices without definite granules or tubercles. Venter subnitid, set with black, decumbent setæ; depressed at base, lightly transversely convex on intermediate segments; apical segment slightly depressed with a median longitudinal sulcus bounded posteriorly by a less defined transverse impression, the lips of the median sulcus raised in a small projection above junction with the transverse impression; apical margin evenly rounded, not bisinuate. Legs simple; anterior tarsi symmetrical.

♀ Similar to male; prothorax with granules more rounded, less elongate; elytra more produced, the apex strongly bimucronate, tubercules fewer and more spaced out on second interstice. Venter strongly convex, apex rounded, not bisinuate.

Dimensions.—♂ 17×6 mm.; ♀ 17×6.5 mm.

Hab.—N.S. Wales, Capertee (T. G. Sloane and H. J. Carter).

Described from one male and three females, all of which agree in having no tubercles on the second and fourth interstices.

Associated with these, and from the same locality, are four males and a female, which differ in having elongate, spaced out tubercles on the second and third interstices, the sutural interstice is also less raised, except at base, while the punctures are less regular. I can see no other difference except that the prothoracic granules are less elongate.

I am undecided whether these represent a distinct species, or are merely individual variations; I am inclined to the former view, but have thought it better not to affix a name to the specimens while doubt exists as to their status.

The dimensions of these specimens with the number of tubercles on the second and fourth interstices vary somewhat, and are given in the following table:—

Sex.	Dimensions.	Second Interstice.	Fourth Interstice.
♂ . . .	16 × 5.5 mm.	.. 6—8	.. 5
♂ . . .	15 × 5 ,,	.. 2	.. 4—5
♂ . . .	17 × 6.5 ,,	.. 4—5	.. 5
♂ . . .	18 × 7 ,,	.. 2—3	.. 3
♀ . . .	17.5 × 7 ,,	.. 4	.. 3—5

Sclerorinus meliceps, Pasc.

Pascoe, Journ. Linn. Soc., 1873, p. 10; Ferguson, Proc. Linn. Soc. N.S. Wales, 1915, xl., p. 801.

When in London I had an opportunity of examining the type ♂ of this species in the British Museum, and made the following notes:—

"*Sclerorinus meliceps,* Pasc. ♂ (Type), belongs to subcostatus group and allied to *S. squalidus.* Prothorax with small round granules, abraded in centre. Elytra with depressions irregular, transverse, not deep; granules prominent, about equal in size to interstitial granules; these granuliform forming continuous rows on the third, fifth and sixth, at intervals on the second and fourth, hardly distinguishable from the other granules. Median vitta yellow. Middle tibiæ notched. Setæ yellow."

Hab.—Queensland.

This species was unknown to me at the time I revised the genus, and provisionally it was placed in group V. It should however come into group IV., and next to *S. squalidus,* Macl.

SCLERORINUS BESTI, n.sp.

A small species in general appearance resembling the tuberculosus-germari group, but with simple intermediate tibiæ.

♂ Black; densely clothed with dark brown, minute, subsquamose pubescence, vittate with creamy; head with a median vitta bifurcate on rostrum; prothorax and elytra trivittate, the inner surfaces of the tubercles also with lighter clothing; lower margins of elytra vittate with creamy; venter with yellowish brown macules in mid line, and with black hairs on apical segment only.

Head convex, running into rostrum without any definite line of demarcation. Rostrum with external ridges subparallel, running back on to head, somewhat broader posteriorly; median area laevigate, raised, carinate; sublateral sulci elongate, deeper posteriorly. Antennæ rather short, scape stout, funicle with joints short, first slightly longer than second. Eyes ovate.

Prothorax subangulate on sides, widest across middle; apical margin rounded above, produced somewhat over head, with definite ocular lobes; subapical constriction rather strongly marked; median line free from granules, but not definitely impressed; disc set with comparatively large rounded granules, rather distantly placed and absent along median and sublateral vittæ; sides with indications of granules in front. Elytra elongate, gradually widened to behind middle; apex widely rounded; base emarginate, humeral angles with a large somewhat obtuse tubercle; punctures small and obscure, except between second and third rows of tubercles, where they are distinct; with three rows of strong conical tubercles; first interstice with a row of granules, second interstice with a row of 6-7 tubercles, elongate anteriorly, but not extending to base, larger and more acute posteriorly, and extending half-way down declivity; third interstice with 6-8 similar tubercles, but starting from base and ending on edge of declivity; fourth without tubercles; fifth with a short row of 4 small tubercles, including humeral tubercle, followed almost in the same line by 5 large tubercles on the sixth interstice; lateral interstices, with a few depressed granules. Venter flattened; apical segment concave, the sides produced ventrally, with an acute angle, somewhat incurved posteriorly, the centre of the concavity occupied by a brush of thickly set hairs, the lateral portions more deeply excavate. Apex of last dorsal segment narrow, but rather strongly setigerous. Legs simple, intermediate tibiæ not notched.

♀ Similar to ♂, but more rounded on elytra; elytral tubercles similar, but a subapical tubercle present on one side in the only ♀ before me. Ventral segments convex, apical segment not excavate, but with a small round depression at extreme apex.

Dimensions.—♂ 12×4.5 mm.; ♀ 12×5 mm.

Hab.—Victoria, Portland (J. E. Dixon).

Although undoubtedly a *Sclerorinus* as that genus is at present understood, I am undecided to what group to assign the present species. It is referred to Section II. with some doubt as the median vitta is incomplete, being practically only represented by the long hairs on the apical segment, this segment is however not channelled as in Section I. The tubercles of the fifth interstice would place it in Group V., and it has a resemblance to the *tuberculosus-germari* portion of the group, but the tibiæ are simple, and it bears little likeness to the rest of the group. The structure of the apical ventral segment is quite unlike that of any member of the fifth group, but is similar to that found in Group II., but the members of this group are otherwise very different.

I am indebted for four specimens (3 ♂ ♂, 1 ♀) to Mr. J. E. Dixon, and have much pleasure in naming the species after his friend and fellow-collector—Mr. D. Best, of Melbourne.

Types in author's collection.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. I., 1921].

Art. V.—*New Australian Coleoptera with Notes on some previously described Species, Part I.*

By F. ERASMUS WILSON.

(Communicated by J. A. Kershaw.)

(With Text Figure.)

[Read 9th June, 1921].

BYRRHIDAE.

Pedilophorus venustus, n.sp.

Head and prothorax brassy, with a purplish tinge; elytra bright metallic green, under surface reddish-fuscous; appendages paler. Portions of upper surface glabrous, but in parts clothed with a dense semi-decumbent golden pubescence, forming definite patterns, this interspersed with much longer and more erect dusky hairs; under surface and all appendages with paler pubescence.

Head widely rounded in front, with dense and sharply defined punctures. Antennæ with joint 1 very stout, and darker than the following ones; 3 thin, and a little longer than 2; 4, 5, 6 subequal; 7 somewhat transverse; 8, 9, 10 strongly transverse, and with 11 forming a stout club; 11 viewed from above pointed, and about twice the length of 10; viewed from the side, however, it is seen to be bluntly rounded. Prothorax strongly convex, sides near base quite vertical; punctures as on head. Scutellum small, punctured. Elytra strongly convex, sub cordate, punctures very much fewer and sparser than on prothorax. Epipleurae narrow, terminating at hind coxae, with a few ill-defined punctures. Under surface heavily punctured, except on disc of metasternum, where they are much finer and sparser.

Length.—3, breadth 2, mm.

Habitat.—Victoria: Fern Tree Gully, Warburton (F. E. Wilson).

Compared with a co-type of *P. raucus*, Blackb., the present species differs in being much smaller, colouration different, elytra, disc of metasternum and legs, with very much finer and sparser punctures, and clothing forming distinct patterns. These patterns however may easily lose their symmetry where a specimen has become greasy. Four specimens were secured at Fern Tree Gully, and six at Warburton by sieving damp moss collected from treefern trunks and old logs.

Type in author's collection.

Pedilophorus globosus, n.sp.

♂ Reddish-brown, becoming darker in places, glabrous, nitid. Legs, palpi and two basal joints of antennæ fuscous, rest of antennæ darker; antennæ finely pubescent, clypeus with a few longer hairs. Under surface and legs clothed with very short pale pubescence, densest on apical ventral segment.

Head rather large, with somewhat sparse, but well-defined punctures, fairly uniformly distributed; antennæ moderately long; joint 1 very stout; 2 thinner, and decreasing towards apex; 3 much thinner, and approximately equal to the three following combined; 4, 5, 6 slightly decreasing in length; 7 rounded; 8, 9, 10 transverse, and forming with 11, which is stout, and bluntly pointed, a well defined club. Prothorax smooth, strongly convex, almost twice as long as broad, rounded in front, and evenly decreasing in width from base to apex; lateral margins narrow. Scutellum apparently wanting. Elytra smooth, very convex, almost continuous with outlines of prothorax; epipleurae very broad to about hind coxae, then becoming abruptly, but evenly narrowed down to their termination just beyond base of apical ventral segment. Under a high power the abdominal segments appear to have fairly numerous shallow transverse depressions on their surface, this being not so noticeable on the apical segment.

Length.—1.5 mm.

Habitat.—Victoria: Warburton, near the summit of Mount Donna Buang, Fernshaw (F. E. Wilson).

In the type and one other specimen the ♂ sexual organs are well exserted, and consist of a fairly long, parallel-sided penis, on either side of which are two acutely pointed horny processes.

When highly magnified a very obscure transverse row of dark spots can be discerned on the prothorax, just above the basal margin. One specimen of the twelve under examination is almost quite black, the others being coloured as in the type. This species comes nearest to *P. atronitens*, Lea, but may be easily distinguished from that species by its glabrous upper surface, less distinct cephalic punctures, and in having a club composed of 4 joints only as against 5 in *atronitens*. All my specimens were secured from damp moss, collected from old logs during the month of April.

Type in author's collection.

PEDILOPHORUS RAUCUS, Blackb.

Byrrhus raucus, Blackb., Trans. and Proc., Roy. Soc. S. Aust., xiv., 1891, p. 133.

I am not aware of any previous record of members of the genus *Pedilophorus* being associated with ants, practically all the known species having been taken either in moss or in flood debris. Whilst I also have taken *P. raucus* in moss, I have to record the finding of sixteen specimens in a single nest of a small ant at Lakes' Entrance.

My friend, Mr. C. Oke, has also collected from ants' nests at Bacchus Marsh specimens of a Pedilophorus which I believe to be this species, although I have not had an opportunity as yet of carefully examining his material.

EROTYLIDAE.

EPISCAPHULA RUFOLINEATA, n. sp.

♂ Black, nitid, all markings yellowish red; apex, sides and about half base of prothorax margined by a moderately broad band; prothorax subequally divided into four zones by three irregular longitudinal stripes starting from the front marginal band, the centre one falling a little short of the basal margin, the two outer ones joining the basal marginal band; each elytron with a stripe bordering about half the base, and continuing around the scutellum a short distance down suture; an irregular fascia beginning near suture at about one-third, and meeting at outer edge a narrow marginal stripe starting from shoulder, the latter passing a little beyond its juncture with fascia; a somewhat irregular stripe beginning near apex, passing up near suture, then gently curved outwards, meeting margin at about two-thirds, from whence becoming attenuated, it returns along the margin to apex; all appendages castaneous except club of antennæ, which is black.

Head moderately distinctly punctured on clypeus, more sparsely elsewhere; eyes widely separated from scape by a rounded outward projection of head. Prothorax about one-third wider than long, lightly but frequently punctured, except on the side margins, which are almost impunctate, and in the shallow depressions on either side of base, where there are a few well defined larger punctures. Elytra faintly punctured; punctures tending to arrange themselves in series, this most pronounced near suture. On the pale markings there are a few black spots, which also suggest being placed in longitudinal series. Scutellum strongly transverse. Prosternum with punctures fairly numerous, except on intercoxal projection, on the outer edge of which there are several shallow longitudinal sulci. Mesosternum lightly, metasternum more heavily, punctured, the latter also with a well defined longitudinal sulcus on disc.

Length.—7.5; breadth, 3.5 mm.

Habitat.—Queensland: Mt. Tambourine (A. M. Lea and H. Pottinger); Blackall Ranges (F. E. Wilson); National Park (H. Hacker).

The ♀ may be distinguished by its much shorter antennæ and legs, and its considerably less dilated front tarsi.

Some specimens are somewhat larger than the type, and the elytral markings are more or less variable. Specimens from Mount Tambourine are all very similar, but two from Blackall Ranges, and one from the Queensland National Park, exhibit the variation as shown in figure B; figure A representing the markings of the type.

Type in author's collection.

Fig A

Fig B.

STAPHYLINIDAE.

Megalops melbournensis, n. sp.

Upper surface, with the exception of elytra, and the flavous apex of sixth visible abdominal segment, jet black; elytra red, the whole highly polished; antennæ with joints 1-8 testaceous, 9-11 black. Femora and tibiæ dark, but with their bases and apices paler; tarsi and palpi flavous, mandibles becoming paler at their apices. Under surface with mouth parts, gular, a border around metasternum, and trochanters testaceous, the rest black, and the whole nitid.

Head subtriangularly produced in front, with very large foveate punctures, except at apical margin and on disc; eyes finely faceted; antennæ with joint 1 cylindric, thick, 2 thinner and nearly equal to the three following combined, 3-8 monoliform, 8 somewhat longer than the preceding one, 9-11 forming a very conspicuous club, joints 1-8 with a few setae, 9-11 rather strongly pubescent. Prothorax about as long as broad, sides produced into a blunt tooth just above basal half, and again between that point and apex, strongly convex, with irregular punctures as on head, punctures tending to arrange themselves in circular series; unpunctured spaces somewhat raised. Scutellum small, truncate behind, with two large foveate depressions in middle. Elytra about the length of prothorax, subsutural striae well defined, disc of each elytron with two wide, deep, obscurely punctate striae, which neither attain the base nor apex of elytra; midway between these and the lateral border are a few large irregular punctures arranged longitudinally; near apex of each elytron at sutural angle are a few irregular indistinct striae. Abdomen narrower than elytra; arranged across basal halves of each segment are a series of large shallow depressions, these becoming less distinct on apical segments; apical declivity of each segment with several transverse rows of fine lines; lateral margins of abdomen with sparse decumbent pubescence. Under surface with prosternum punctured as on pronotum, metasternum with a few smaller setigerous punctures on disc only, abdominal segments with somewhat similar punctures arranged transversely.

Length, 3.75 mm.

Habitat.—Victoria: Melbourne (F. E. Wilson and Ejnar Fischer), Noble Park, Preston (F. E. Wilson).

This species may be readily distinguished from *M. nodipennis*, Macl.,[1] by its different colouration, its much more even prothoracic surface, and the absence of the nodular excressences on the elytra, which is so characteristic a feature of that species.

My friend, Mr. Fischer, and myself first secured this species from beneath the bark of red gums that had been recently flooded by the overflow of the Yarra. Other specimens were found by me later under a piece of bark lying on the ground, and beneath stones.

Type in author's collection.

PSELAPHIDAE.

Articerus wilsoni, Lea.

(Trans. and Proc. Roy. Soc. S. Aust., xliii., 1919, p. 169.)

This species, which was named by Mr. A. M. Lea from specimens which I secured from nests of *Iridiomermyx detectus*, at Eltham, near Melbourne, evidently is widely distributed, as a ♂ example was found by me last October in a nest of the same ant at Caboolture, some thirty miles north of Brisbane. Mr. Lea tells me that Mr. Elston has also lately obtained a specimen from a nest of *I. detectus* near Adelaide, so that probably wherever this ant is located specimens of the Pselaphid will be found also.

SCARABAEIDAE.

Panelus bidentata, n. sp.

Upper surface generally black, but with sides of prothorax towards apex, shoulders, and a spot on each elytron on outer edge near apex, red; basal 2 and apical 3 joints of antennæ darker than the intermediate ones; legs with femora and tibiae dark testaceous. Under surface with palpi and prosternum testaceous, the rest blackish.

Head large, depressed in front, somewhat convex behind, armed with two prominent prongs jutting out in front, space between prongs evenly rounded, punctures numerous and well defined, becoming slightly larger towards base. Prothorax about one and a-half times broader than long, moderately convex, sides sub-parallel to within about one-third of apex, then strongly narrowed; puncturation much as on head. Elytra at base slightly

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1. Trans. Ent. Soc. N.S.W., vol. ii., pp. 150.

wider than prothorax, sides evenly rounded, rather strongly convex, with seven striae on each elytron, arranged singly; interstices flat, uniformly covered with a minute meshwork of fine lines; on the centre of each interstice at extreme base there is a minute nodule, but this would not be visible if the prothorax and elytra were closely applied. Scutellum minute, rounded behind. Under surface with metasternum moderately punctured, abdominal segments with a transverse row of minute punctures at their extreme base, but apical segment with a few extra punctures scattered about.

Length.—3, breadth ·2, mm.

Habitat.—Victoria. Lakes Entrance (F. E. Wilson).

This interesting little Scarab was secured when sieving leaf debris collected in a thickly scrubbed gully near the landing stage at Kalimna, Lakes' Entrance.

I have not seen a specimen of *P. pygmaeus*, Macl., but my friend, Mr. A. M. Lea, to whom I showed this specimen, tells me that in *pygmaeus* the elytral striae are arranged in geminate series, and that the prothoracic punctures are less coarse. *P. pygmaeus* also has no red markings.

Type unique in author's collection.

CHRYSOMELIDAE.

Oomela bicolor, n.sp.

Flavous, nitid; apical five joints of antennæ, head, a large basal marking on prothorax, a transverse marking on each elytron, somewhat nearer base than apex; scutellum, tarsi, femora and base and apex of the four anterior tibiae, black or darker.

Head with a sharply defined, sparsely punctate depression midway between antennæ, another very shallow, ill defined one between eyes, and two others leading from upper ocular margins towards the infra antennal depression; antennæ with joint 1 thick, 2 shorter and somewhat oval, 3-6 elongate, subequal, 7-11 much thicker, 11 considerably longer than 10, and pale at apex. Joints 1-6 sparsely clothed with pale pubescence, 7-11 more densely clothed with darker pubescence. Prothorax about three and a-half times as wide as long, moderately convex, basal and apical width subequal, front angles moderately rounded, hind angles more acute, sparsely and very minutely punctured. Elytra slightly wider than prothorax, sides evenly rounded, with regular rows of punctures, becoming almost obsolete on apical declivity; interstices with a few minute punctures.

Length.—3 mm.

Habitat.—Queensland: Goodna (F. E. Wilson).

This species apparently comes closest to *O. variabilis*, Lea,[2] but differs from the description of that species in the sculpture of the head, shape of prothorax and markings. A pair of these rather handsome little Chrysomelids were secured from beneath the bark of a rotting log.

Type in author's collection.

Chalcolampra parvula, n. sp.

Broadly ovate, very convex; head, sides of prothorax, base of elytra and suture broadly, sides of elytra narrowly, reddish-brown, the rest black, and the whole nitid. First four joints of antennæ testaceous, the rest darker; legs flavous. Upper surface (with the exception of a few setae on front margin of clypeus) glabrous. Under surface brownish-red.

Head sparsely and rather indistinctly punctured, with a shallow depression just above each eye, clypeal suture broadly v-shaped, reaching back a little beyond the points of insertion of antennæ; about midway on each arm of the suture is a deep circular depression, between which and the eye the cephalic surface is somewhat raised; eyes very coarsely granulate; antennæ with joint 1 very stout, 2 thicker than 3, 3 nearly twice as long as 4. Prothorax strongly depressed, about three times as broad as long, sides narrowly margined and rounded, but slightly incurved towards middle, anterior angles a little produced, posterior rounded; with fairly large, though sparsely distributed, punctures, becoming less frequent at sides. Scutellum subtriangular, smooth, impunctuate. Elytra very convex, continuous with sides of prothorax, widest about midway, with nine rows of well defined punctures on each elytron, seventh and eighth row starting from a common puncture somewhat distant from the base of elytron, ninth row obsolete at about one-third; interstices with sparse smaller punctures.

Under surface with a depression on disc of metasternum, mesosternum and metasternum with sparse setigerous punctures, abdominal segments with scattered setigerous punctures and suf-

2. Trans. Roy. Soc., S.Aust., vol. xl., pp. 431.

face shragreened; elytral epipleurae rather wide, evenly decreasing from about midway between intermediate and hind coxae.

Length.—2.75 mm.

Habitat.—Victoria: Belgrave (F. E. Wilson).

Looked at from the side this little species is seen to have an outline forming a complete half circle. My unique specimen was obtained when sieving leaf debris, gathered at the foot of a treefern, growing in a very damp gully.

Type in author's collection.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. I., 1921.]

Art. VI.—*The Australian Species of Carex in the National Herbarium of Victoria.*

By J. R. TOVEY.

[Communicated by Professor A. J. Ewart, Ph.D., D.Sc., &c.]

[Read 12th May, 1921.]

In his Monograph of the Cyperaceae—Caricoideae in Engler's Pflanereich IV.-20 (1909)—Kukenthal has changed the nomenclature of several of the Australian species of Carex and his systematic arrangement is quite different from that given in Mueller's Census of Australian Plants.

As Engler's Pflanzereich is not readily available to many botanical workers, it was thought that the following notes giving the systematic arrangement according to Kukenthal, and also the distribution of the species in the National Herbarium, might be of some use to those interested in the above subject.

It will be noted that several species which were included by Mueller and Bentham under well known European species have been considered by Kukenthal to be distinct, and some that have hitherto been recognised as valid, have been reduced to varieties, whilst others that have been looked upon previously as synonyms have been raised to specific rank.

Genus CAREX.

Sub-genus 1. Primocarex.

C. ACICULARIS, Boott in Hook. f. Fl. N.Z., 280 t. 63 (1853).

Victoria. It is also recorded from New South Wales and Tasmania, but there are no specimens from either of these States in this Herbarium.

C. RARA, Boott in Proc. Linn. Soc. i., 284 (1845).

Subspecies C. CAPILLACEA, Boott. Illustr. Caric. i., 44 t. 110 (1858.)

New South Wales.

C. PYRENAICA, Wahlenb, in Vet. Akad. Handl., Stockholm, xxiv., p. 139 (1803.)

Var. CEPHALOTES, Kukenthal in Engl. Pflanzer, iv.-20, p. 106 (1909), (C. CEPHALOTES, F.v.M.)

Victoria; New South Wales.

Sub genus 2. **Vignea.**

C. CHLORANTHA, R. Br. Prodr. 242 (1810).
Victoria; New South Wales; Tasmania.

C. DECLINATA, Boott, Illustr. Caric. iv., 171, t. 58 (1867).
New South Wales; Queensland.

C. TERETICAULIS, F.v.M. Fragm. viii., 256 (1874).
Victoria; South Australia; West Australia; Tasmania.

C. APPRESSA, R.Br. Prodr., 242 (1810). (*C. paniculata, F.v.M.* non L.)
Victoria; New South Wales; Queensland; South Australia; West Australia; Tasmania.

Forma 1 DIAPHANA, Kukenthal. (*C. paniculata,* var. *subdiaphana.*)
Queensland and South Australia.

Forma 2 MINOR, Kukenthal (*C. chlorantha,* var. *composita, Benth.*)
Victoria; New South Wales; Tasmania.

Var. VIRGATA, Kukenth, in Engl. Pflanzr., iv.-20, p. 179 (1909).
New South Wales; Tasmania.

C. INVERSA, R.Br. Prodr., 242 (1810).
Victoria; New South Wales; Queensland; South Australia; Tasmania.

Forma 1 PARVULA, Kukenth.
New South Wales.

Forma 2 MAJOR, Boott.
Victoria; West Australia.

Var. LEICHHARDTII, Boeck.
New South Wales; Queensland.

C. HYPANDRA, F.v.M. Fragm., viii., 259 (1874).
Victoria; New South Wales.

C. CANESCENS, L. Spec. Plant. i. 274 (1753).

Var. ROBUSTIOR, Blytt. ex Anderss. Cypr. Scand. 57 (1849).

Victoria; New South Wales.

C. STELLULATA, Good, in Trans. Linn. Soc., II., 144 (1794) (*C. echinata,* Boeck non Murr.)

Victoria; New South Wales.

Sub-genus 3. **Indocarex.**

C. INDICA, L. Mant. II., 574 (1771) var. FISSILIS, Kukenth. (*C. fissilis,* Boott.).

Queensland.

Sub-genus 4. **Eucarex.**

C. GAUDICHAUDIANA, Kunth. Enum. II., 417 (1837) (*C. vulgaris,* Fries. var. *Gaudichaudiana,* Boott.) (*C. caespitosa,* F.v.M. non L.)

Victoria; New South Wales; Queensland; South Australia; Tasmania.

Var. HUMILIOR, Kukenthal in Engl. Pflanzr. iv.-20 p. 313 (1909).

Tasmania. Kukenthal records this variety from New South Wales, but there are no specimens from that State in this Herbarium.

Var. CONTRACTA, Kukenthal in Engl. Pflanzr. iv.-20, p. 313 (1909).

(Syn. *C. contracta,* F.v.M.)

New South Wales.

C. POLYANTHA, F.v.M. in Trans. Phil. Soc. Vict. i., 110 (1855). (*C. acuta,* F.v.M. non L.)

Victoria; New South Wales.

C. CERNUA, Boott. Illustr. Caric. iv., 171, t. 578 (1867).

Var. LOBELIPES, Kukenthal in Engl. Pflanzr. iv.-20, p. 354 (1909) (*C. lobelipes,* F.v.M.)

New South Wales.

C. BUXBAUMII, Wahlenb. in Vet. Akad. Handl, Stockholm, xxiv. 163 (1803).

Victoria. This is also recorded from New South Wales, but there are no specimens from that State in this Herbarium.

C. MACULATA, Boott. in Trans. Linn. Soc., xx., p. 128 (1846).

Var. NEUROCHLAMYS, Kukenth in Engl. Pflanzr. iv.-20, p. 428 (1909) (*C. neurochlamys*, F.v.M.).

New South Wales; Queensland.

C. BREVICULMIS, R.Br. Prodr., 242 (1810).

Victoria; New South Wales; South Australia; Tasmania.

C. BRUNNEA, Thunb. Fl. Jap., 38 (1784) (*C. gracilis*, R.Br.).

New South Wales; Queensland.

C. LACISTOMA, R.Br., Prodr., 243 (1810).

Kukenthal records this species from New South Wales, but it is not represented in this Herbarium.

C. BROWNII, Tuckerm. Enum. Meth. 21 (1843).

Victoria, New South Wales.

C. ALSOPHILA, F.v.M. Fragm. viii., 257 (1874).

Victoria.

C. LONGIFOLIA, R.Br. Prodr., 242 (1810) (*C. longibrachiata*, Boeck).

Victoria; New South Wales; Queensland; Tasmania.

C. GUNNIANA, Boott. in Trans. Linn. Soc. xx. 143 (1846).

Victoria; New South Wales, South Australia; and Tasmania.

Var. BARBATA, Kukenth. in Engl. Pflanzr. iv.-20 p. 663 (1909) (*C. barbata*, Boott.).

Kukenthal records this variety from Tasmania, but it is not represented in this Herbarium.

Var. BREVIOR, Kukenth. in Engler's Pflanzr. iv.-20 p. 663 (1909).

This variety is recorded from Gippsland, Victoria, by Kukenthal, but it is not represented in this Herbarium.

C. OEDERI, Retz. Fl. Scand. Prodr. 179 (1779). Var. CATARACTAE, Kukenth. in Engl. Pflanzr. iv.-20, p. 675 (1909), (*C. cataractae,* R.Br.), (*C. flava,* Benth., non L.)

Tasmania.

C. TASMANICA, Kukenth. in Bull. Herb. Boiss, 2nd Ser. iv., 59 (1904).

Tasmania.

C. PREISSII, Nees in Lehm. Pl. Preiss ii. 94 (1846).

West Australia.

C. PSEUDO-CYPERUS, L. Spec. Pl. ed. i. 97 (1753) var. FASCICULARIS, Boott. (*C. fascicularis,* Soland).

Victoria; New South Wales; Queensland; South Australia; West Australia; Tasmania.

C. PUMILA, Thunb. Fl. Jap. 39 (1784).

Victoria; New South Wales; South Australia; Tasmania. It is also recorded from Queensland, but there are no specimens from that State in this Herbarium.

Var. BICHENOVIANA, Kukenth. in Engl. Pflanzr. iv.-20, p. 740 (1909) (*C. Bichenoviana,* Boott.) (*C. haematostoma,* Boeck. non Nees).

Victoria; New South Wales.

This variety is also recorded by Kukenthal from South Australia and Tasmania, but it is not represented from either of these States in this Herbarium.

C. RICHMONDII (Boott. M.S.). Clarke in New Genera and Species of Cyperaceae in Kew Bull. Ad. Ser. 8, p. 83 (1908).

This is recorded from Tasmania, but Kukenthal does not record this species in his Monograph, and there are no specimens of it in this Herbarium.

Systematic arrangement according to Mueller.		Systematic arrangement according to Kukenthal. The numbers show the order of sequence.
C. cephalotes, F.v.M.	=	(3) C. pyrenaica, Wahl. var. cephalotes, Kukenth.
C. acicularis, Boott.	=	(1) C. acicularis, Boott.
C. capillacca, Boott.	=	(2) C. rara, Boott. (subspecies C. capillacea, Boott.)
C. inversa, R.Br.	=	(8) C. inversa, R.Br.
C. canescens, L.	=	(10) C. canescens, L.
C. echinata (Murr.) Boech non Murr.	=	(11) C. stellulata, Good.
C. hypandra, F.v.M.	=	(9) C. hypandra, F.v.M.
C. chlorantha, R.Br.	=	(4) C. chlorantha, R.Br.
C. paniculata (L), F.v.M. non Linn.	=	(7) C. appressa, R.Br.
C. declinata, Boott.	=	(5) C. declinata, Boott.
C. tereticaulis, F.v.M.	=	(6) C. tereticaulis, F.v.M.
C. haematostoma (Nees), Boech. non Nees	=	(29a) C. pumila, var. Bichenoviana, Boott.
C. fissilis, Boott.	=	(12) C. indica, L. var. fissilis, Kukenth.
C. brunnea, Thunb.	=	(19) C. brunnea, Thunb.
C. contracta, F.v.M.	=	(13a) C. Gaudichaudiana, Kunth. var. contracta, Kukenth.
C. caespitosa (L.), F.v.M. non Linn.	=	(13) C. Gaudichaudiana, Kunth.
C. acuta (L.), F.v.M. non Linn.	=	(14) C. polyantha, F.v.M.
C. lobolepis, F.v.M.	=	(15) C. cernua, Boott. var. lobolepis, Kukenth.
C. flava (L.), Benth. non Linn.	=	(25) C. Oederi, Boott. var, cataractae, Kukenth.
		(26) C. tasmanica, Kukenth.
C. Buxbaumii, Wahl.	=	(16) C. Buxbaumii, Wahl.
C. pumila, Thunb.	=	(29) C. pumila, Thunb.
C. breviculmis, R.Br.	=	(18) C. breviculmis, R.Br.

Systematic arrangement according to Mueller.		Systematic arrangement according to Kukenthal. The numbers show the order of sequence.
C. Neesiana, Endl. This is from Norfolk Island only, hence not Australian.		
C. Preissii, Nees.	= (27)	C. Preissii, Nees.
C. Gunniana, Boott.	= (24)	C. Gunniana, Boott.
C. Bichenoviana, Boott.	= (29a)	C. pumila, var. Bichenoviana, Boott.
C. maculata, Boott.	= (17)	C. maculata, Boott., var. neurochlamys, Kukenth.
C. lacistoma, R.Br. (partim)	= (20)	C. lacistoma, R.Br.
C. lacistoma, R.Br. (partim)	= (21)	C. Brownii, Tuckerm.
C. alsophila, F.v.M.	= (22)	C. alsophila, F.v.M.
C. longibrachiata, Boech.	= (23)	C. longifolia, R.Br.
C. pseudo-cyperus (L.)	= (28)	C. pseudo-cyperus, L. var. fascicularis, Boott.

[PROC. ROY. SOC. VICTORIA, 34 (N.S.), PT. I., 1921].

ART. VII.—*An Intercomparison of Important Standard Yard Measures.*

BY J. M. BALDWIN, M.A., D.SC.

[Read 14th July, 1921.]

In the year 1843 a committee[1] was appointed to superintend the re-establishment of the standards of length and of weight with a view of replacing the standards destroyed by fire in 1834. Forty similar bronze bars were cast in 1845, each bar 38 inches long, and one inch square in cross section. Near each end a cylindrical hole half an inch in diameter, and half an inch deep was sunk, the distance between the centres being 36 inches. At the bottom of each hole is a gold plug about 0.1 inch in diameter with three fine lines at intervals of about 0.01 inch transverse to the axis, and two lines about 0.03 inch apart parallel to the axis. The distance to be measured is that between the middle transverse lines measured from mid-way between the longitudinal lines.

One of these bars was taken as a reference standard, and each of the others was compared with this. At the close of the comparisons the bars were numbered, and the temperature at which each was standard was engraved on the top surface, which bore the following inscription:—

> "Copper 16 oz. tin 2½ zinc 1 Mr. Baily's Metal No. . . . Standard Yard at . . . . Fahrenheit. Cast in 1845. Troughtons & Simms, London."

Bar No. 1, Standard Yard at 62.00°F. was chosen as the Imperial Standard for determining the length of the Imperial Standard Yard,[2] and four others as Parliamentary copies. The reference yard was preserved to serve as a standard for reference, while the remaining bars were distributed throughout the world. One bar—No. 40, Standard Yard at 61.99°F.—is in the possession of the Melbourne Observatory. It differs from the others in that on the top surface "Experimental Bar A" is engraved instead of "Cast in 1845." No special reference is

1. G. B. Airy, Account of the Construction of the New National Standard of Length, Phil. Trans., Vol. 147. Part III., 621—702, 1857.
2. Weights and Measures Act, 1878, First Schedule.

made to this in the Committee's report; presumably it was cast shortly before the other bars. This bar is in good preservation and the lines on the plugs are very good.

There is also at the Melbourne Observatory a second standard yard of similar metal and of the same length and cross section. The cylindrical holes are ¼-inch in diameter, and only 0.1 inch deep, with gold plugs as before, but the lines parallel to the axis are ⅛-inch apart. The lines are not good, the central one on one plug being distinctly curved, and on the other not of uniform width. This bar was constructed in 1864, and is marked as standard at 57° Faht. The certificate issued by the Exchequer is dated 4th June, 1866. The bar will be referred to as (1383).

The expansion of 36 inches of the bronze used is given by Airy as 0.000341 ins. per degree Fahr. (l.c., p. 681), so that, assuming the permanence of the bars, the original comparisons would give (40)—(1383) = —.00170 inches when the bars are the same temperature. In August, 1915, these two bars were compared, and preliminary measures showed that (40)—(1383) = +.002 inches. At this time the history of (40) was unknown to me, but the workmanship gave evidence that it had been prepared with much greater care than (1383). The temperature at which the bars were standard was given in the one case as 61.99° F., in the other as 57° F. This pointed to the work of comparison of (40) having been more accurately carried out. The difference between the original and the later comparisons was so marked that it was impossible from the evidence before me to have any certainty of what the standard yard really was, and it was impossible at that time to send one of the bars to England to be re-investigated. In this difficulty, inquiries were made of the Deputy Warden of the Standards as to the history of bar (40), but before the receipt of his reply, it was identified by means of the paper cited above as being one of the original forty standard yard bars, and it was found that similar standards had been sent to Sydney and to Hobart. Further enquiries showed that these standards were still in existence, and thus a way was opened for an accurate determination of the yard by means of an intercomparison of these three original bars, each a replica of the British Imperial Standard Yard bar. After considerable delay, I was authorised by the Victorian Government to arrange for this intercomparison, and through the courtesy of the Minister for Lands of New South Wales, and the Treasurer of Tasmania, the bars were brought to Melbourne, and the inter-comparison was carried out by me at the Melbourne Observatory during the months, June-November, 1918.

The New South Wales bar, No. 18, Standard at 62.26° F., was found when examined at the Melbourne Observatory to be in good condition, a few spots only appearing on the main portion of the bar, and the lines on the gold pins were very good. The Tasmanian bar, No. 37, Standard at 62.07° F., appeared in good condition as regards the outer surface, but on examining the lines under the microscope, those on the left hand plug were found to be fearfully scraped and utterly ruined; the only part for pointing on is at one end of the terminal line, outside the longitudinal lines. In the comparisons, pointings on the other terminal line were made at about the same distance outside the longitudinal lines, but evidently the original comparison of the bar cannot be used.

In the meantime the comparator to be used had been improved and had been given its final form, the micrometer screws investigated, and revolution values determined. The two microscopes used were supported in heavy cast iron stands which rested on a massive slate slab on stone piers isolated from the floor, the whole forming a most stable system. The microscopes can be raised and lowered, and the optical axis made vertical by three adjusting screws and lock nuts. The illumination is most important. A small electric lamp was fixed to the microscope tube a little above the objective. The light from it passed through a hole in the tube on to a cover glass inclined at 45° to the vertical, and thus the light was thrown vertically through the objective on to the line on the bar. This arrangement gave a good illumination. It could be somewhat improved by interposing a lens between the lamp and the hole in the tube, thus enabling the lamp to be moved further away. The lamp was switched on only while the pointing was being made.

Two girders were bolted across from pier to pier, and on these were supported the rails on which the heavy wooden moving table ran. Cast iron tables, planed on the upper surface, three ins. wide and 48 ins. long, were supported near the ends by strong screws, fixed firmly into iron castings screwed to the moving table. These screws served for raising and lowering the cast iron table through a range of three inches. There were two of these tables side by side separated by a space of one inch.

Each of the two standard yards being compared was supported by a system of eight rollers, connected in groups of four, equi-spaced as described on p. 629 of the Phil. Trans. Vol. 147, the interval being $38/\sqrt{63}$ inches. The main support of each system of four rollers was a casting resting on three screws, the points of the screws being fixed relative to the tables by a point slot and plane arrangement.

With the limited means at my disposal it was impossible to have a constant temperature bath, but provision against rapid change in temperature was made by enclosing the whole of the supporting tables and the standards in a box, of which the moving table formed the bottom, the sides and top being wooden frames with panels of zinc outwards, and thick strawboard inside. The top was in three sections, to leave space for the microscopes to pass through. Two thermometers were supported horizontally midway between the standard bars. Throughout the whole comparisons the greatest care was exercised to eliminate the effect of any progressive change, and the bars were measured in every arrangement. Thus in comparing two bars, A and B, eight series were made.

North/South: A/B, A/ꓭ, ∀/ꓭ, ∀/B, B/∀, B/A, ꓭ/A, ꓭ/∀,
so that any constant difference in temperature caused by the presence of the observer, who always was to the north, should have no effect on the final result. A series consisted of eight sets, the pointings in a set being in the order a, b, c, d, d, c, b, a where a, b, are the terminal lines on one bar, c, d those on the other bar. In the sets the first pointing was made on each line in turn. A series occupied about half an hour, and during this time the temperature of the thermometers in the box rose about 0.3°C. At the close of a series, the bars were placed in position for the next series, and a minimum time of about two hours elapsed before the next series was started. It is hoped that with the precautions observed any difference in temperature is entirely eliminated from the final mean.

There were thus in all 64 comparisons between any pair of bars, and in each comparison eight pointings were made, arranged symmetrically so as to eliminate any linear progressive change. There is no need to give full details of the readings; it will suffice to state that in no case did the difference between the extreme readings in the 32 comparisons of a group of four series exceed .00020 inch, this including all sources of error except that arising from a constant difference in temperature between the bars depending on which occupied the North position.

The final mean from the comparisons are expressed by the following equations of condition, the subscript numbers referring to the mean temperature of comparison, and the absolute term being in inches.

				Computed	O–C.
$(37)_{52\cdot4}$	$-\ (40)_{52\cdot4}$	=	+·00018	+·00019	-1×10^{-5}
$(18)_{49\cdot2}$	$-\ (37)_{49\cdot2}$	=	–·00034	–·00035	+1
$(37)_{48\cdot7}$	$-\ (1383)_{48\cdot7}$	=	+·00176	+·00173	+3
$(18)_{53\cdot3}$	$-\ (40)_{53\cdot3}$	=	–·00016	–·00016	0
$(1383)_{56\cdot0}$	$-\ (18)_{56\cdot0}$	=	–·00136	–·00137	+1
$(1383)_{61\cdot2}$	$-\ (40)_{61\cdot2}$	=	–·00152	–00153	+1

The bars are all of the same alloy, and so the coefficients of thermal expansion can be assumed equal, and the equations solved for the three unknowns: (18)—(40), (37)—(40), and (1383)—(40). Giving equal weight to each equation the solution is—

(18) = (40) — .00016 ins.
(37) = (40) + .00019 ins.
(1383) = (40) — .00153 ins.

(37) is so badly injured that the original determination cannot be used for fixing its length, while for (1383) it is almost certain that some error has been made in the reductions of the original comparisons. Hence only (18) and (40) remain for establishing the yard. The original comparisons give the temperatures at which they are standard as 62.26°F. and 61.99°F. respectively, from which it follows—

Original comparison, (18)—(40) = —.00009 ins.
Present comparison, (18)—(40) = —.00016 ins.

so that a relative change of .00007 inches between the two standards is indicated. This is of the order of changes shown between the similar bars which serve as Parliamentary Copies (see Report by the Board of Trade (Weights and Measures), 1912, p. 11). To distribute this change, assume that (18) has diminished by half the amount, while (40) has increased by half the amount. This change of .000035 inch corresponds to a change in the standard temperature of 0.10°F.

The final results are given in the following table:—

Bar.	Standard at Original.	Standard at Present.	Length at 62° F. Original in.	Length at 62° F. Present. in.	Difference. P – O. in.
18	62·26° F.	62·36 F.	1 yd. – ·00009	1 yd. – 00012	– ·00003
40	61·99	61·89	+ 0	+ 4	+ 4
37	62·07	61·32	– 2	+ 23	+ 25
1383	57	66·4	+ 171	– 150	– 321

The changes shown in bars (18) and (40) are quite probable. The change in bar (37) can be explained by the fact that pointings in the present series had to be made on a small part near the end of one of the terminal lines, instead of midway between the two longitudinal lines. The difference in bar (1383) is altogether too large to be explained by a change in the length of the bar. The most probable explanation is that in the original comparison a mistake was made in the sign of the correction—that the bar, instead of being too long, as shown on the certificate, was in reality too short. This would assume that the temperature of comparison was 61.7°F., a quite likely temperature.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. I., 1921.]

Art. VIII.—*The Petrology of the Ordovician Sediments of the Bendigo District.*

By J. A. DUNN, B.Sc.
(Howitt Natural History Research Scholar, 1920).

[Read 14th July, 1921.]

1. Introduction.

The Ordovician sediments form practically the only rocks actually represented in Bendigo, and outcrop over almost the whole area except where occasionally covered by shallow alluvium. The structure of the series has been so thoroughly described by numerous geological workers in the past, particularly E. J. Dunn[1] and F. L. Stillwell,[2] that no description is here needed. One or two points may however be noted.

An exhaustive examination of the graptolites obtained from different parts of the field has shown that the Lancefield, Bendigo and Castlemaine zones of the Lower Ordovician are represented here, but there is, however, no lithological difference in the representatives of these three zones. There is every gradation between a typical sandstone and a typical slate, and these are the only representatives of the original sediments. The fresh slate has a dark to light bluish-grey colour, the sandstone a dark to light grey shade. On weathering this is altered to a buff colour in both cases, the slates being generally darker than the sandstone, except where the latter have been almost entirely replaced by limonite. The limonite staining is derived from the decomposition by meteoric waters of the pyrite contained in the fresh rock, and replaces the clayey material, and constitutes the more important cement of the weathered rock. Where, however, the importance of the limonite as a cementing medium is small, the sandstone becomes a soft, porous, crumbly sandstone, and the slate a fine greasy fissile material.

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2. "Report on the Bendigo Goldfield," Nos 1 and 2. E. J. Dunn, Geol. Surv. Vict. 1896.

2. "Gold Deposition in the Bendigo Goldfield," Parts I., II., and III. F. L. Stillwell. Bull 4.8 and 16. Adv. Council Sc. and Industry.

2. Composition of the Sediments.

Secondary silica has, in many cases, altered the character of the original sediments, but it is quite apparent that as a whole both the sandstones and slates were highly aluminous. The principal minerals identified microscopically are quartz, felspar, muscovite, and biotite (generally altered to chlorite). The accessories detected are tourmaline, zircon, rutile, ilmenite (often altering to leucoxene), magnetite, apatite and sphene. A small pale-bluish isotropic mineral with very high refractive index was detected in one section of sandstone—this is probably blue spinel. Secondary minerals present are quartz, pyrite, arsenopyrite, sphalerite, galena, chlorite and a carbonate probably ankerite. Sericite constitutes practically the whole of the ground-mass of the slates, leucoxene often appears secondary to ilmenite, whilst chlorite generally occurs after biotite. In a number of the slates, particularly those found on the "backs," black carbonaceous matter constitutes an integral part of the rock, and generally occurs in thin lamellae.

(a) Essential Minerals examined in thin sections.—The detrital quartz and felspars range to about .7 mm. as a maximum in the standstones and mica often occurs in long, thin ragged plates up to 1 mm. in length.

The quartz is rounded to sub-angular in habit generally, but often where secondary it becomes sharply angular. Only in very rare instances does it show crystal boundaries. Strain polarisation is rarely evident except in some of the secondary quartz. The characteristic serial arrangement of inclusions is often noticeable, and apatite, zircon and rutile are occasionally found as inclusions. Thin veins of quartz often traverse both sandstones and slates—these veins are in part the result of replacement, and in part of growth by force of crystallisation.

The felspar is in much less quantity than the quartz, and on the whole the individual grains are smaller. Occasionally the felspars are in very turbid grey patches, but generally they are rather fresh and represented by both orthoclase and plagioclase. The plagioclase ranges from andesine to oligoclase as shown by the angle of extinction, and is not so abundant as the orthoclase. The felspars are almost universally rounded in habit, but where they are probably secondary, they become quite angular, as in the case of quartz. The alteration of the felspars is as a rule to sericite, but occasionally it goes to calcite.

Both detrital and secondary mica occurs, the former as long, ragged, cleaved fragments of muscovite up to 1 mm. in length, and as rounded and ragged plates. Although for the most part quite clear and colourless, it occasionally alters to a pale green chlorite. The muscovite is often found bent and nipped between the quartz grains, and this is characteristic of every section examined. Biotite occurs in one or two of the sandstones, but is practically all altered to a greenish and brownish chlorite.

The secondary mica is generally represented by sericite, occurring throughout the ground-mass of all the rocks, and making up practically the whole of the slates. The sericite constitutes most of the original clayey matter of the ground-mass of the sandstones, and at times is the result of alteration of the felspars. Some of the plates of muscovite may possibly be secondary.

(b) Accessory Minerals.—Tourmaline is the dominant accessory, and was detected in every section of sandstone. Both the blue and brown pleochroic varieties are represented in grains up to .2 mm. diameter. Generally it occurs as rounded detrital grains, but occasionally it shows traces of crystal boundaries. Only in one case was tourmaline found to occur in slate, and in that instance it was included in secondary arsenopyrite.

Zircon occurs in all of the sections, never exceeding more than .25 mm. diameter. It is always clear and colourless, and generally slightly rounded, though still showing crystal boundaries. It is not so abundant in the slates as in the sandstones.

Rutile occurs in a number of the sections, but rarely exceeds more than .1 mm. diameter. Generally the grains are somewhat rounded, brown and violet pleochroic tints being common.

Apatite is a rather constant accessory in many of the sections in grains up to .3 mm. maximum. Although sometimes rounded, it always shows traces of crystal boundaries.

The determination of sphene in some of the sections is doubtful, owing to the difficulty of distinguishing it from zircon in small grains. But one or two boat-shaped crystals, with oblique extinction appear rather definite.

Ilmenite is quite a common accessory in all the rocks, occurring as irregular grains generally altering to leucoxene. Magnetite also occurs in irregular grains, rarely in minute octahedra.

Carbonaceous material occurs especially in the slates, and is probably the result of the decay of some form of life in the sediments during their deposition.

(c) Secondary Minerals.—Quartz is the chief secondary mineral. Practically all the Bendigo rocks are silicified to a greater or less extent. This secondary silica occurs either in the ground-mass, or at times it forms small angular grains of quartz which have grown from definite points by force of crystallisation; this often gives the appearance of a sandstone to what was originally a slate. At other times the quartz acts as a border to secondary cubes of pyrite, generally bordering the quartz only in the direction of the cleavage of the slates.

Chlorite is an important secondary mineral. In part this appears to have been brought in with the secondary siliceous solutions, but occasionally it is secondary to muscovite, biotite and tourmaline.

Mineral carbonates, probably ankerite, are common as secondary minerals, generally replacing the ground-mass of both slates and sandstones, and occasionally replacing grains of felspar. These carbonates also appear to have accompanied the secondary siliceous solutions.

Pyrite, pyrrhotite, arsenopyrite, sphalerite, and galena occur distributed throughout the whole series. They occur both irregularly, and with definite crystal boundaries, and are probably contemporaneous with the siliceous solutions.

Leucoxene is secondary after ilmenite. The greater part of the sericite is also secondary, particularly in the slates and ground-mass of the sandstones—it is evidently the alteration product of the clayey material of the original sediments.

Heavy Liquid Separation of Minerals.

By means of heavy liquids, the minerals occurring in small quantity in a sample of sandstone were isolated and examined as grains under the microscope. A typical sandstone from the 2400 feet level of the Sea Mine was crushed, then ground in a disc crusher, and passed first through an 80-mesh sieve, then part through a 100-mesh, thus giving two grades of fineness. These were then weighed:—

2817 grams through 100-mesh.
 438 grams through 80 mesh, and over 100-mesh.

3255 grams total.

These grades were each panned off separately to ensure cleaner panning. Residues were panned three times to have a minimum loss of heavier minerals. By this means all slimes were got rid of, as well as a large proportion of the quartz. Concentrates dried, then passed under electro-magnet to separate any magnetic minerals. The magnetic minerals on examination consisted entirely of magnetite. This was also weighed:—

.9130 grams magnetite through 100-mesh.
.2889 grams magnetite through 80-mesh and over 100.

1.2019 grams magnetite total.

Magnetite in sandstone: .0307 per cent.

The demagnetised samples were each separated into a lighter and heavier portion, by means of flotation in bromoform S.G. 2.90, on the lines indicated by T. Crook, A.R.C.Sc. (Dublin), F.G.S., in "The Petrology of the Sedimentary Rocks," Hatch and Rastall. The concentrates obtained, i.e., the heavier portions, were weighed—

8.301 grams through 100-mesh.
3.756 grams between 80 and 100-mesh.

12.057 grams total concentrate.

These concentrates were seen to be heavily charged with sulphides, as pyrite and arsenopyrite. They were therefore first roasted to oxide, then again passed under electromagnet to eliminate pyritic matter, but a good deal of Fe_2O_3 still remained. Hence the only recourse left was to take it into solution with weak Hydrochloric acid, the leached residues being then filtered, dried and weighed—

2.7368 grams through 100-mesh.
0.4520 grams between 80 and 100-mesh.

3.1888 grams total.

Substracting this from the above 12.057 grams we find there was a total of 8.868 grams of sulphides in the sandstone, mainly pyrite.

Sulphide in sandstone—.2730 per cent.

The acid solution was tested for phosphate, as apatite appeared to be the only likely soluble mineral present. Presence of phosphate confirmed.

The filtered residues were noted to contain quite a large amount of quartz, hence a further heavy solution separation was undertaken. Bromoform being now unobtainable, methylene iodide, diluted to S.G. 3.133 was used for the purpose. This would also eliminate the large amount of muscovite which the rock sections had shown to be present. The final concentrates obtained were weighed:—

.0658 grams heavy minerals through 100-mesh.
.0091 grams heavy minerals between 80 and 100-mesh.

.0749 grams heavy minerals total.

Heavy minerals in sandstone—.0023 per cent.

The heavy minerals were then examined under the microscope in media of different refractive indices, the following minerals being detected: Zircon, tourmaline, ilmenite, rutile, topaz, sphene, magnetite, spinel, apatite, biotite, corundum, pyrrhotite, arsenopyrite, chalcopyrite, pyrite, gold; some quartz, chlorite, and muscovite, probably brought down with other minerals during flotation; and perhaps monazite.

Zircon is, with tourmaline, the most abundant. The crystals almost always show perfect prismatic and pyramidal faces, and in many cases are zoned.

Tourmaline occurs abundantly as both the brown and bluish varieties, generally in irregular grains, although a crystal face can be occasionally detected.

Ilmenite is generally altered to white leucoxene, showing in many cases a black, unaltered core.

Rutile occurs in well-formed prisms, sometimes dark brown in colour, sometimes violet tinted.

Topaz occurs generally in irregular grains, but occasionally shows prismatic outlines. The colours vary from colourless, through straw yellow to light greenish yellow.

Sphene is present in angular and rounded brown grains, generally not so clear as zircon and rutile. The determination is rather doubtful.

Pleonaste, an almost opaque form of spinel, was represented by two or three octahedra. Practically black, but greenish tint detected on edges.

Apatite showing rounded boundaries, owing to the leaching in HCl occurs in colorless and pale-bluish grains.

Corundum, or sapphire, occurs, but only three irregular grains noted, deep blue in colour, and rather pleochroic.

One or two round grains with very high refractive index and birefringence were noted, possessing a strong honey-yellow colour, are probably monazite, although the distinction from rutile is doubtful.

Pyrrhotite, arsenopyrite, chalcopyrite, pyrite and gold were detected. The first four were evidently unacted on by the acid for some reason. The gold occurs in two or three irregular grains, and is quite evidently not detrital. Even after the grinding which the gold would have received during crushing, it appears quite crystalline, while one grain is thin and skeleton-like, as if it had occurred in a mineral which had been dissolved by acid. This inclines the writer to the view that the gold was included in pyrite, and on solution of this latter, was left as the minute grains noted—the largest is not greater than .2 mm. diameter. It is a well-known fact that throughout Bendigo pyrite carries gold often in considerable quantities. It may be here noted that this gold could not have been included during crushing, sieving or panning, as the disc crusher was first thoroughly cleaned with pure silica, the sieves and pans also thoroughly cleaned. The writer is convinced the gold was inherent in the sample.

Magnetite was detected in minute grains, evidently having escaped separation by the electro-magnet by reason of its small size.

Ragged plates of deep brown biotite, colourless muscovite, and greenish chlorite were detected, and were probably brought down by some of the heavy minerals during flotation.

3. Structural Alterations and Metamorphism.

The structural alterations of the Bendigo rocks are wholly dynamic—the development of cleavage in the more argillaceous sediments with the production of slates. No shales or mudstones are represented, all having been converted into slates. As these become more arenaceous, however, the cleavage is less developed, until in the true sandstone there is no evidence of it whatever. These structural changes are certainly a result of the same intense forces that brought into existence the peculiar regular and acute folding so typical of the area. Although the Ordovician is intruded by numerous monchiquite dykes (generally in the neighbourhood of the anticlinal axes), there has been no alteration of the walls of country rock. This is probably accounted for by the almost instantaneous intrusion of the molten material, the magmatic heat being quickly conducted away from the walls.

Some eight miles south of Bendigo, at Big Hill, the Ordovician, at the contact with the Harcourt granitic mass, has been somewhat metamorphosed.[3] Typically the sandstones have been altered to a mica hornfels, and the argillaceous sediments to spotted and andalusite slates. For the most part, however, the alteration is rather an induration than an absolute change in the mineral content of the rocks.

4. Deposition of the Sediments.

By numerous writers in the past, some of the Ordovician beds of the Bendigo goldfields have been referred to as deposited in shallow water, owing to the common occurrence of ripple-marking.[4] It was first thought by Dr. Hall, and later confirmed by T. S. Hart[5] that the origin of these pseudo ripple markings is due to the intense compressive forces to which the rocks have been subjected. It appears probable that during the process of folding, the resultant stresses along the bedding planes caused movement of the beds over each other, with the concomitant production of minute puckers in the more plastic beds. This may be the explanation of the more common occurrence of this pseudo ripple-marking in the slates than in the sandstones of Bendigo. Hence, this evidence of apparent ripple-marking cannot be accepted as a criterion of the shallow-water deposition of the sediments.

The general fineness in grain of the rocks rather points to the deposition of the sediments some distance from the shore, probably in the relatively deep-water of a continental shelf. The often rapid succession of exceedingly minute bands of slate and sandstone, with the admixture of occasional quite coarse sandstones, suggests that the sediments were laid down under variable currents, probably a result of tremendous floods washing the material from various sources.

3. "Report on the Bendigo Goldfield," No. 1. E. J. Dunn, page 7.

4. "Report on the Bendigo Goldfeld," No. 1. E. J. Dunn, page 6.

5. "On some Features of the Ordovician Rocks at Daylesford, with a Comparison with Similar Occurrences elsewhere." T. S. Hart, M.A., B.C.E., Proc. Roy. Soc. Vic., 1901, page 175.

5. Origin of the Mineral Contents.

W. G. Langford,[6] in his discussion of the constitution and origin of the Melbourne Silurian Sediments, pointed out that there were two possible sources of the material for the silurian sediments. So also there are two possible sources of the Ordovician sediments:—

(a) They may have been derived from a pre-Ordovician igneous rock.

(b) They may have been derived from a pre-Ordovician sedimentary rock.

The presence of such minerals as muscovite, tourmaline, zircon, rutile, ilmenite, magnetite, apatite, topaz, and sphene would perhaps point to an igneous rock as the origin of the sediments, but being stable minerals they may easily undergo transportation from the sediments of one period to a later.

Biotite is very rare, and is generally altered to chlorite, but its presence would indicate either an igneous or a metamorphic origin, as would also the fresh felspars which are occasionally met with. In the sandstones, felspar grains are very few in number compared with the quartz, and are sometimes represented by turbid patches. The slates and the fine sericitic ground-mass of the sandstones, however, are purely argillaceous, and must have originally been of the nature of clay, which in its turn, must have come into being through the prolonged breakdown of felspars. The extreme fineness of this clayey material would rather point to an older sediment as the derivation of the greater part of it. The clear unaltered felspars, though few in number, would tend to show that at least part of the constituent mineral content was derived from an old igneous or metamorphic rock.

The gradual transition from Heathcotian to Lower Ordovician throughout Victoria eliminates the possibility of the Heathcotian being the source of the material, whilst any possible Pre-Cambrian outcrops are quite unknown anywhere within 100 miles of Bendigo.

The writer pictures, then, in the Lower Ordovician period, a gradually sinking landmass, probably to the east, over which outcropped Pre-Cambrian metamorphic sediments, intruded perhaps by occasional igneous masses. The denudation of this land

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6. "The Petrology of the Silurian Sediments near Melbourne." W. G. Langford, B.Sc., Proc. Roy. Soc. Vic., Vol. XXIX., n.s., Part I., 1916.

mass provided the material for the Ordovician sediment. These in many cases had to be transported over long distances, so that felspars would be rarely preserved—only those derived from close at hand would remain as clear grains.

This work was undertaken at the suggestion of Professor E. W. Skeats, in order to attempt an examination of the Ordovician sediments as W. G. Langford[7] had done of the Silurian. In order to bring the two works on to a comparative descriptive basis, the writer has set his work out on as similar lines to those of Langford as space would allow.

Mineralogically, W. G. Langford's inference that the Ordovician and Silurian would contain somewhat similar constituents[8] is borne out, but it may be noted that the occurrence of strain polarisation in the quartz grains is not by any means common as Langford inferred may be the case. It is perhaps possible that the Melbourne Silurian sediments have been derived from an area where the Ordovician has been subjected to even still greater compressive forces than in the Bendigo area. Mineralogically, the only difference between the constituents of the two series appears to be the relative absence of sapphire and unaltered biotite in the Ordovician.

In conclusion the writer wishes to acknowledge his thanks to the Bendigo School of Mines' officials for the use of their assay laboratory; to Dr. F. L. Stillwell for the invaluable use of his rock sections; and to Professor E. W. Skeats and Dr. H. S. Summers for their occasional excellent advice.

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7. Op. cit.
8. Op. cit., page 49.

[Proc. Roy. Soc. Victoria 34 (N.S.), Pt. I., 1921.]

Art. IX.—*On an Inclusion of Ordovician Sandstone in the Granite of Big Hill.*

By J. A. DUNN, B.Sc.,

(Howitt Natural History Research Scholar, 1920).

[Read 14th July, 1920.]

1—Foreword.

Big Hill lies some eight miles S.W. of Bendigo, overlooking the wide expanse of undulating plain extending southwards to Harcourt, Castlemaine and Maldon. Big Hill is one of a series of ranges surrounding the saucer-shaped Harcourt granitic area, all being in the nature of residuals, owing their existence to the metamorphism and induration of the Lower Ordovician at the contact of the granitic intrusion. The original sediments near Big Hill have been altered in places to quartzite and mica hornfels, chiastolite often showing in the slates. Well preserved specimens of the altered Ordovician are practically unobtainable, the rocks having been weathered and leached to a considerable depth, in some places below 400 feet.

The exact line of contact between granitic intrusion and Ordovician is, at Big Hill, rather indeterminate owing to the accumulation of hill wash and alluvium on the hill slopes, and at the foot of the hills. However, in places large granitic boulders are found protruding above the surface, and by closely following the beds of the small creeks, the limits of the granitic mass may be very closely delineated.

2.—Ordovician.

The Ordovician of Big Hill forms the southern extension of the Bendigo Goldfields, and there are probably three horizons of the Lower Ordovician represented here—Lancefield, Bendigo and Castlemaine. The well-formed anticlines and synclines so typical of Bendigo extend south-west, right up to the Harcourt granitic mass at Big Hill, remaining undisturbed both in dip and strike at the contact. In fact, the Big Hill range may be looked upon as the southern limit of the Bendigo Goldfields, for the slopes of the range have been costeened and scratched for gold in the past, although in rather a spasmodic manner.

The sediments are represented by sandstones and slates of varying composition and texture, there being every gradation between the normal sandstone and normal slate. In Bendigo these have been mineralised to some considerable extent by the impregnation of quite a high percentage of pyrite, with lesser amounts of arsenopyrite, galena and sphalerite. At Big Hill these sulphides are practically absent, but the Ordovician has been metamorphosed fairly extensively with the formation of micaceous sandstone (in some places the mica is in quite coarse plates), whilst the occurrence of chiastolite in the slates is common throughout the metamorphic aureole.

Inclusion of Country Rock (A), surrounded by Basic Segregation (B), in Granite (C).

3.—The Harcourt Granite Intrusion.

The granitic mass of Harcourt has never been critically examined, but it has generally been looked upon as a granodiorite similar to that of Macedon, Dandenong, Mount Eliza and Mount Martha. The high percentage of SiO_2 and the possibility that many of the twinned felspars may be anorthoclase, as will be indicated later, point to the probability of the rock being a soda-rich granite similar to that at Station Peak. In fact, it is remarkably like this latter, often containing large phenocrysts of felspars although perhaps not as large as the You Yangs specimens.

Numerous veins of aplite and tourmaline aplite traverse the granitic mass, and also run out into the Ordovician at the contact. It is, however, with the method of intrusion and the differentiation of the Harcourt plutonic magma that this paper is more directly concerned.

The accompanying photograph is of an inclusion of country rock in the granite near Big Hill. This specimen occurs on the south slope of Big Hill, in the bed of a small tributary to Bullock Creek, and is situated at least 200 yards from the contact of the intrusion with the Ordovician. At this point the tributary has exposed the bare surface of the granite over an area of a few square feet, and has rounded and smoothed the rock surface considerably. As will be noted from the photograph, the inclusion (A) stands up in relief from the granite surface (C). Surrounding the inclusion, except for two inches on the right-hand side, is what appears to be a basic segregation (B) from the hand specimen, and this latter, in contrast to both Ordovican inclusion and surrounding granite has been eroded to a maximum depth of three inches below the granite surface. Two very thin, light-coloured veins or threads cut through both the country rock and segregation, and apparently run into the granite at the side where the granite is in actual contact with the sandstone inclusion. The original sandstone has been altered to a considerable extent.

Description of specimens:—

Granite, Big Hill.—A light grey apparently normal granite of quartz, felspar and biotite, often containing fairly large crystals of felspar. Under the microscope shows typical granitic texture. Abundant quartz and orthoclase in large allotriomorphic crystals, twinned and zoned felspars ranging from oligoclase to albite in smaller crystals, but relatively abundant and approximately equalling orthoclase in amount. Owing to the extremely minute twinning of some of the felspars, they may be possibly anorthoclase. In two or three of the large orthoclase crystals extremely thin lamellae can be just barely detected, pointing to a possible soda variety. Microperthitic intergrowth of albite in orthoclase is common. Brown biotite altering in places to chlorite is an essential constituent. Accessories are apatite (occasionally in large crystals), zircon, and rarely sphene.

A determination of the silica percentage gave a result closely approximating Daly's average of 69.92 for true granites—this result is given later. The silica percentage is rather high for a granodiorite, and it is thus very possible that some of the apparent plagioclase felspars may be anorthoclase.

Basic Segregation around Inclusion, Big Hill.—A dark-grey, fine to medium-grained holocrystalline rock, consisting in the hand-specimen of quartz, felspar, and abundant biotite. Both in texture and appearance, it is quite distinct from the surrounding granite.

Microscopically the rock is seen to be much finer in texture than the granite. There is a large increase in plagioclase, decrease in percentage of quartz, whilst orthoclase is not at all common. There is also a slight increase in biotite, whilst apatite, though still relatively abundant, never occurs other than as small crystals. Other accessories are zircon, sphene, and a little magnetite in biotite. Biotite altered in part to chlorite.

This rock is the equivalent of a typical granodiorite, the silica percentage (see later) approximating closely to Daly's average of 65.15 for granodiorites.

Inclusion of Altered Sandstone, Big Hill.—A fine-grained, light-buff coloured rock, containing a good deal of mica.

Microscopically the section shows a granular quartz mosaic, with occasional sub-angular grains of orthoclase and plagioclase. Abundant biotite, generally occupying interstices between quartz grains. Detrital zircon and apatite, whilst needles of apatite are often included in the quartz grains.

The rock is evidently a re-crystallized sandstone.

There are two possible modes of formation of the basic segregation open to discussion, explained by each of the two hypotheses of magmatic differentiation postulated by Daly and Bowen respectively.

4.—Mechanics of Intrusion.

(a) Accepting first Daly's hypothesis of magmatic stoping combined with marginal assimilation, we would picture the molten igneous mass intruding its way up through the Ordovician by magmatic stoping, assimilating the country rock as it progresses. The particular inclusion at Big Hill would be looked upon as a fragment of Ordovician which had not been entirely digested, whilst the surrounding basic segregation would be explained as granite which in the immediate neighbourhood of the Ordovician had its composition altered by solution of the sedimentary rock. Under normal circumstances of slow diffusion, the alteration of composition of the granite would be a gradual and progressive one, from a maximum at the surface of the country rock outwards to the normal granite. The acute change of composition of this segregation at the margins would, however, be explained by picturing the fragment as being localised to a certain definite neighbourhood until a state of equilibrium was reached so far as slow diffusion was concerned. For some short distance around the fragment of sandstone, the granite magma would now be of an approximately similar composition throughout. If now further movement of the magma took place, so that the position of the fragment were altered—as, for instance, if the sandstone commenced to sink—then this equilibrium would be immediately disturbed. A certain amount of the surrounding altered magma would be carried with the inclusion and corroded by the magma to some extent, until finally, the whole granitic intrusion crystallized out.

On this hypothesis of magmatic stoping and marginal assimilation it would, as a necessary corollary, be presupposed that the segregation immediately surrounding the fragment would be of a composition intermediate between that of the granite, and included country rock, i.e., an inclusion of higher SiO_2 content than the granite should give a surrounding segregation of more acid composition than the granite, while a more basic inclusion would give a segregation of less acid composition. The upholding of this supposition by chemical analysis would go a long way towards the acceptance of the hypothesis, whilst a negative result from chemical analysis would mean the absolute rejection of the hypothesis of marginal assimilation so far as this occurrence is concerned. The following are the average silica contents of the three rock types as shown by analyses kindly undertaken by Miss McInerny, of the Geology School, University of Melbourne:—

Country rock (sandstone)	78.30 per cent. SiO_2
Segregation	65.30 per cent. SiO_2
Granite	69.79 per cent. SiO_2

The segregation is thus not of an intermediate composition, the SiO_2 content being lower than either of the other two; hence the hypothesis of marginal assimilation as applied to the explanation of the origin of the segregation surrounding the Big Hill inclusion of country rock must be rejected.

(b) The theory of magmatic differentiation upheld by Bowen affords an excellent explanation of the origin of the basic "aureole" to the inclusion. This "aureole" would represent a portion of the chilled border facies attached to the roof, and subsequently broken off with some of the country rock, to be incorporated in the parent magma. At the intrusion of the molten magma, the cooling at the marginal walls would be ahead of the cooling of the main mass, and here there would probably crystallize out a rock of the same composition as the molten magma at that instant. The main mass of the magma would remain still liquid, and as cooling progressed differentiation by sinking of crystals would continue, the liquid magma becoming more and more acid until, ultimately, the whole would crystallize out, producing as an ideal result an acid alkalic magma with a less acid and more calcic border (the chilled border facies). But prior to the crystallization of the main liquid magma, picture a rejuvenation in the mechanical activity of the magma brought about perhaps by earth movement, so that magmatic stoping commenced afresh. Picture also a small roof pendant of country rock projecting into the magma, and around which a "chilled border facies" has crystallized. With the renewal of magmatic stoping this roof pendant and its attached basic granitic border will break away from the main country rock, and sink into the liquid magma to be perhaps slightly corroded, but finally isolated in the granite on solidification of the magma. This will also explain the curious shape of this particular inclusion of Big Hill—a fragment of country rock (about six inches wide and two feet long), surrounded by a basic segregation except on that side which may be pictured as the area of attachment to Ordovician roof.

This, then, is quite an acceptable explanation of the origin of this inclusion, and considered as such, the Big Hill inclusion affords excellent evidence of the possibilities of both Daly's hypothesis of magmatic stoping, and Bowen's research on the differentiation of rock magmas, particularly as applied to the origin of "chilled border facies."

By J. M. LEWIS, D.D.Sc., Melb.

[Art. XV., Proc. Roy. Soc. Victoria, 33 (N.S.), 1921].

Owing to a number of errors having escaped correction by the author, the Council has agreed to its separate issue with alterations and certain additions. Those specially interested in the subject may obtain a copy on application to the author, Dental College, Melbourne.

END OF VOLUME XXXIV., PART I.

[Issued 31st October, 1921].

Publications of the Royal Society of Victoria, and of the Societies amalgamated with it.

VICTORIAN INSTITUTE FOR THE ADVANCEMENT OF SCIENCE.

Transactions. Vol. 1. 1855.

PHILOSOPHICAL SOCIETY OF VICTORIA.

Transactions. Vol. 1. 1855.

These two Societies then amalgamated and became:—

PHILOSOPHICAL INSTITUTE OF VICTORIA.

Transactions. Vols. 1–4.

The Society then became:—

ROYAL SOCIETY OF VICTORIA.

Transactions and Proceedings (Vol. 5, *entitled* Transactions). (8vo). Vols. 5–24.

Transactions. (4to). Vols. 1, 2, 3 (Pt. 1 only was published), 4, 5, 6——1888——.

Proceedings (New Series). (8vo). Vols. 1——1888——.

MICROSCOPICAL SOCIETY OF VICTORIA.

Journal (Vol. 1, Pt. 1, *entitled* Quarterly Journal). Vol. 1 (Pts. 1 to 4), 2 (Pt. 1), title page and index [*all published*]. 1879–82.

[*The Society then combined with the* ROYAL SOCIETY OF VICTORIA].

NOTE.—*Most of the volumes published before 1890 are out of print.*

PROCEEDINGS

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VOL. XXXIV. (NEW SERIES).

PART II.

Edited under the Authority of the Council.

ISSUED 31st MAY, 1922.

(Containing Papers read before the Society during the months of August to December, 1921).

THE AUTHORS OF THE SEVERAL PAPERS ARE INDIVIDUALLY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

MELBOURNE:

FORD & SON, PRINTERS, DRUMMOND STREET, CARLTON

1922.

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[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. II., 1922.]

Art. X.—*An Alphabetical List of Victorian Eucalypts.*

By J. H. MAIDEN, I.S.O., F.R.S., F.L.S.

(Government Botanist, and Director of the Botanic Gardens, Sydney.)

[Read 11th August, 1921.]

This is a supplement to a paper, "A Census of Victorian Eucalypts and Their Economics," *Rep. Aust. Assoc. Adv. Sci.*, XIV., 294 (1913), by R. T. Baker.

The letters C.R. and F.F. indicate my "Critical Revision of the Genus Eucalyptus" and "Forest Flora of New South Wales" respectively. In these works I have, as a rule, indicated the references to Victorian localities.

It seems to me that we have 62 species proved to be indigenous to Victoria.

1. E. alpina, Lindl.

See C.R., Part IX., p. 259, Plate 41 (1907).

2. E. Baueriana, Schauer. (Synonym *E. Fletcheri*, R. T. Baker).

See C.R., Part XIII., p. 120, Plate 59 (1911); also F.F., Part LVII., p. 149, Plate 215 (1916).

The Metung, Victoria, specimens were collected by A. W. Howitt, and also by myself, following his directions. In C.R., Part XLII., I have enumerated some other Victorian specimens; these are in the Melbourne Herbarium, and were included in *E. polyanthemos* by Mueller. I have lately received the species with smaller leaves, simulating in that respect *E. populifolia* to some extent, from Mr. Harry Hopkins, from Orbost and the Tambo River.

3. E. Behriana, F. v. M.

See C.R., Part X., p. 335, Plate 48 (1909); also F.F., Part XLVI., p. 111, Plate 172 (1912).

4. E. bicolor, A. Cunn.

(Quoted by Mr. Baker as *E. pendula*, A. Cunn., at p. 298, and as *E. pendula*, F.v.M., at p. 302).

See C.R., Part XI., p. 6, Plate 49 (1910); also F.F., Part XLIV., p. 76, Plate 164 (1911).

There is no such species as *E. pendula,* F.v.M., so far as I am aware, but notes on *E. pendula,* Page, and *E. pendula,* A. Cunn., will be found at pp. 7 and 8 of Part XI. of my C.R. (1910). They are *nomina nuda* and synonyms of *E. bicolor,* A. Cunn.; see p. 6 of that Part, and Plate 49. For some Victorian localities of *E. bicolor,* see p. 10.

5. E. Blaxlandi, Maiden and Cambage.

See *E. capitellata,* at p. 83 below.

6. E. Bosistoana, F.v.M.

See C.R., Part XI., p. 1, with Plate 49 (1910); also F.F., Part XLIII., p. 58, Plate 160 (1911).

7. E. botryoides, Sm.

See C.R., Part XXIII., p. 51, Plates 98, 99 (1915).

8. E. calycogona, Turcz.

See C.R., Part III., p. 83, Plate 9 (1903).

9. E. cinerea, F.v.M.

(Synonyms *E. pulverulenta,* F.v.M., non Sims; *E. Stuartiana,* F.v.M., var. *cordata,* Baker and Smith.)

See C.R., XXI., p. 2, 7 (1914).

10. E. cladocalyx, F.v.M.

The fact that Mueller suppressed this (1852) name in favour of his own, later described, *E. corynocalyx* (1860) is historical. I have explained the facts in C.R., Part XXXVI., p. 163 (1919), with the evidence as to the Victorian locality, and elsewhere, e.g., *Proc. Roy. Soc. S.A.,* xli., 341 (1917), and they appear to admit of no controversy.

11. E. Consideniana, Maiden.

See C.R., Part X., p. 312, Plate 46 (1908); F.F., Part XXXVI., p. 90, Plate 136 (1909).

12. E. CORIACEA, A. Cunn.

See C.R., Part V., p. 133, Plates 26-28 (1904); F.F., Part XV., p. 116, Plate 58 (1905).

13. E. CORYMBOSA, Sm.

This was recorded as a Victorian plant by Mueller in his "Eucalyptographia." See C.R., Part XXXIX., p. 246 (1919). See also F.F., Part XII., Plate 45 (1904).

14. E. DIVERSIFOLIA, Bonpl.

E. santalifolia, F.v.M., is a synonym of *E. diversifolia,* Bonpl. See C.R., Part XXXIII., p. 84 (1917), together with Part VII., p. 197, Plate 36 (1905).

15. E. DIVES, Schauer.

See C.R., Part VII., p. 190, Plate 35 (1905); F.F., Part XIX., p. 176, Plate 75 (1906).

16. E. DUMOSA, A. Cunn.

I agree with Mr. Baker that this had better stand as a species as distinct from *E. incrassata.* The matter is not free from difficulty, owing to the absence of the type of *E. incrassata,* and I have tried to make the position clear in C.R., Part XXXVIII., p. 223 (1919). For figures see Plate 19, Part IV. (1904). Victorian localities are quoted in both Parts. It is also figured at Plate 245, Part LXV. of F.F., now in the press.

17. E. ELAEOPHORA, F.v.M.

See C.R., Part XIX., p. 275, Plates 82 and 83 (1913).

18. E. EUGENIOIDES, Sieb.

Dealt with in C.R., Part VIII., p. 232, Plates 39 and 40 (1907). See also F.F., Part XXIX., p. 153, Plate 110 (1908).

E. eugenioides, Sieb., var. *nana,* Deane and Maiden, I have identified with *E. ligustrina,* DC.; see C.R., Part XL., p. 332, with Plate 167. I only know it from New South Wales, at no great distance west and south of Sydney, but Mr. Baker quotes Mr. P. R. H. St. John as having found it at Orbost, Victoria. Mr. St. John writes to me recently that he was under the impression that he had sent me one of his Orbost specimens at the time, but he is under a misapprehension, although he wrote to me about it. I therefore hold *E. ligustrina,* DC., in suspense as a Victorian plant for the present.

19. E. FRUTICETORUM, F.v.M., Fragm. ii., 58 (1860-1).

This was subsequently redescribed by Mr. Baker under the name *E. polybractea* (Proc. Linn. Soc. N.S.W., XXV., 692, 1900). The history of the synonymy is given in C.R., Part XI., figs. 6-8, Plate 52 (1910), with a full plate of a specimen named by Mueller himself, in F.F., Part XLII., p. 27, Plate 156 (1911). See also a paper by me, "Is *Eucalyptus fruticetorum,* F.v.M., identical with *E. polybractea,* R. T. Baker?" in *Journ. Roy. Soc. Vict.,* XXVI., 298 (1913). Mr. Baker quotes them as separate species at pages 302 and 307 of his paper.

20. E. GIGANTEA, Hook. (Synonym, *E. delegatensis,* R. T. Baker).

The confusion that has gathered around this species is explained in C.R., Part XX., p. 291, Plate 85 (1914). See also F.F., Part LI., p. 7, Plate 198 (1913), (with photographs).

21. E. GLOBULUS, Labill.

See C.R., Part XVIII., p. 249, Plate 79 (1913); also F.F., Part LXVII., Plate 253, now in the press.

22. E. GONIOCALYX, F.v.M.

See C.R., Part XIX., p. 267, Plate 81 (1913); F.F., Part V., p. 119, Plate 19 (1903).

23. E. GRACILIS, F.v.M.

See C.R., Part XXXIX., p. 265 (1919), as to Victorian localities. See also Part III., p. 81, Plate 12 (1903), as a variety of *E. calycogona,* Turcz.

24. E. GUNNII, Hook. f.

See C.R., Part XXVI., p. 108, Plate 108 (1916).

25. E. HEMIPHLOIA, F.v.M.

See C.R., Part XI., with plate 50 (1910) for discussion of the question as to whether *E. hemiphloia* has for varieties *albens* and *microcarpa* or not. Both these varieties are common in Victoria, while the typical form does not appear to occur there. For a figure of the normal form, see F.F., Part VI., p. 134, Plate 22 (1904).

26. E. INCRASSATA, Labill.

As to whether typical *E. incrassata,* originally described from Western Australia, has been found in Victoria as distinct from the named varieties of this species, I am not prepared to say, in view of the uncertainty which has gathered around *E. incrassata.* The matter is discussed in my C.R., Part XXXVIII., pp. 220 and 223 (1919).

E. INCRASSATA, Labill., var. ANGUSTIFOLIA, Maiden.

I have described no such variety. It is probably a slip of Mr. Baker's pen for var. *angulosa,* Benth. See C.R., Part IV., p. 101, Plate 14 (1904), which occurs in Victoria, see p. 108.

27. E. KITSONIANA, Maiden.

See C.R., Part XXVIII., p. 165, with Plate 117 (1916).

28. E. LEUCOXYLON, F.v.M.

See C.R., Part XII., p. 88, Plate 56 (1910).

29. E. LONGIFOLIA, Otto et Link.

See C.R., Part XX., p. 295, Plate 86 (1914); F.F., Part II., p. 37, Plate 5 (1903).

30. E. MACRORRHYNCHA, F.v.M.

See C.R., Part VIII., p. 225, Plate 39 (1907); F.F., Part XXVII., p. 120, Plate 102 (1907).

31. E. MACULATA, Hook.

This occurs in Gippsland, Victoria, and notes on the localities will be found in C.R., Part XLIII., Plate 178, now in the press. See also F.F., Part VII., p. 164, Plate 27 (1904).

32. E. MACULOSA, R. T. Baker.

See C.R., Part XXVII., p. 127, with Plate 112 (1916).

33. E. MAIDENI, F.v.M.

See C.R., Part XVIII., p. 256, Plates 79 and 80 (1913).

34. E. MELLIODORA, A. Cunn.

See C.R., Part XIV., p. 135, Plate 61 (1912); F.F., Part IX., p. 197, Plate 35 (1904).

35. E. MITCHELLIANA, Cambage.

In *Journ. Roy. Soc. N.S.W.*, LII., 457 (1918), with a plate. Summit of Mt. Buffalo.

36. E. MUELLERIANA, Howitt.

See C.R., Part VIII., p. 219, with Plate 2, Part 1 (1903).

37. E. NEGLECTA, Maiden.

See C.R., Part XXVII., p. 151, with Plate 115 (1916).

38. E. NITENS, Maiden.

See C.R., Part XIX., p. 272, Plate 81 (1913).

39. E. NUMEROSA, Maiden.

For Victorian localities see C.R., Part XXXVIII., p. 233 (1919). For earlier views of the relations of this species, see Part VI., pp. 155, 161, with fig. 1, Plate 30 (1905), and F.F., Part XVII., p. 147, Plate 66 (1905).

40. E. OBLIQUA, L'Herit.

See C.R., Part II., p. 51, Plates 5 and 6 (1903); F.F., Part XXII., p. 20, Plate 83 (1907).

41. E. ODORATA, Behr.

See C.R., Part XI., p. 34, Plate 51 (1910), for some Victorian localities.

42. E. OLEOSA, F.v.M.

See C.R., Part XV., p. 171, Plates 65 and 66 (1912); modified by Part XXXIX., p. 277 (1919). See also F.F., Part LX., p. 271, Plate 226 (1917).

43. E. OVATA, Labill.

I have stated that this includes *E. paludosa*, R. T. Baker, in Part XXVII., p. 140, figs. 6a-6d, Plate 114 (1916). I have re-examined (1920) *E. paludosa* with additional material received from Mr. Baker, which material more closely approximates to the type of *E. ovata* than any I had previously received from him. I have been unable to alter my carefully considered opinion of 1916. (1920).

Concerning *E. camphora,* R. T. Baker, in C.R., Part XXVII., p. 148, with Plate 115 (1916), I have suggested that this may be a variety (*camphora*) of *E. ovata,* Labill. I have (1920) again carefully gone over the *ovata-camphora* material, with the view of re-establishing *E. camphora* if I could do so. I find, however, that additional experience and specimens confirm the opinions I expressed at p. 149 (*loc. cit.*). I find long petioles in both *E. ovata* and *E. camphora,* and think I have fairly stated the position for and against species and variety. I know the tree well, not only having observed it carefully in my Victorian tour in 1900, but in New South Wales before and since. The "dwarf variety" of *Gunnii* of Howitt is stated by Mr. Baker to be his *E. camphora.* At p. 150 (*loc. cit.*) I have stated that Howitt's "dwarf variety (b)" is *E. Kitsoni,* Maiden, and that the "Dwarf Highland form (d)" is *E. neglecta,* Maiden. No other "dwarf variety" is mentioned by Howitt so far as I know, but the "tall mountain form (c)" is *E. camphora,* R. T. Baker, as stated by me.

44. E. Perriniana, F.v.M., non R.T.B. et H.G.S.

I have stated the case in C.R., Part XXVI,. p. 103, with plate 108 (1916).

45. E. pilularis, Sm.

See C.R., Part I., p. 38, Plate 1 (1903); F.F., Part XXXI., Plate 116 (1908).

Having re-examined the Victorian specimen that Mr. Baker quotes on my authority (C.R., I., 38) I withdraw it, believing it to be *E. Muelleriana,* Howitt. It is, however, not quite satisfactory. Professor Ewart informs me, on Mr. St. John's authority, that the specimen attributed to that gentleman was taken from a tree growing in the Melbourne Botanic Gardens. But Professor Ewart also sends me, for examination, a specimen of *E. pilularis* collected at National Park, Sealer's Cove, Wilson's Promontory (J. W. Audas and P. R. H. St. John, 22nd October, 1909), which, although incomplete, is in my view sufficient to validate record of the species as Victorian. Professor Ewart also thinks that the McAlister River record, *Mueller* (B.Fl., iii., 208), is probably correct, although the specimen has disappeared from the Melbourne Herbarium. The most southern New South Wales record for *E. pilularis* known to me is Mogo, near Moruya, and it is hoped that specimens will be collected to connect this with the Victorian one.

46. E. POLYANTHEMOS, Schauer.

See C.R., Part XIII., p. 109, with Plate 58 (1911); also F.F., Part LIX., p. 250, Plate 223 (in both these works lanceolate leaves are not shown). In Part XLII., C.R., will be found additional Victorian localities for the species, including some specimens seen by Mueller.

47. E. RADIATA, Sieb.

See C.R., Part XXXVIII., p. 230 (1919) for Victorian localities. For an earlier view as to *E. radiata,* see Part VI. of the same work. See also F.F. (as *E. amygdalina*), Part XVII., Plate 62 (1905).

Concerning *E. amygdalina,* Labill., and var. *australiana,* Baker and Smith, my latest views in regard to *E. amygdalina* and some of its allies will be found in C.R. Part XXXVIII., pp. 227, 229, 233. I agree with Messrs. Baker and Smith that the presence of the Tasmanian *E. amygdalina* has not yet been proved on the mainland. But both *E. radiata,* Sieber (*E. amygdalina,* var. *australiana*), and *E. numerosa,* Maiden, species formerly looked upon as synonyms of *E. amygdalina,* not only occur on the mainland, but are by no means rare in Victoria.

The *E. radiata,* Sieb., referred to by Mr. Baker at p.305 of his paper, is that tree (a " White Gum ") confused with it by Bentham, Woolls, others and myself, but which I subsequently showed to be another species under the name of *E. numerosa* (see Journ. Roy. Soc. N.S.W., XXIX., 752, 1904).

48. E. REGNANS, F.v.M.

See C.R., Part VII., p. 183, Plate 33 (1905); F.F., Part XVIII., p. 165, Plate 71(1905).

49. E. ROSTRATA, Schlecht.

See C.R., Part XXXIII., p. 68, Plates 136-8 (1917); F.F., Part LXII., p. 49, Plate 223 (1918).

50. E. RUBIDA, Deane and Maiden.

See C.R., Part. XXVI., p. 110, Plates 109-111 (1916). Also F.F., Part LXIII., p. 87, Plate 237 (1920). I concur in Mr. Baker's view that this is *E. viminalis* variety (b) of Howitt, but he has overlooked my same record in *Proc. Linn. Soc. N.S.W.*, XXVI., 578 (1901), 12 years earlier.

51. E. SIDEROXYLON, A. Cunn.

See C.R., Part XII., p. 82, Plate 55 (1910); F.F., Part XIII., p. 70, Plate 49 (1904).

52. E. SIEBERIANA, F.v.M.

See C.R., Part X., p. 306, with Plate 45 (1908); also F.F., Part XXXIV., p. 49, Plate 128 (1909). As regards the confusion with *E. virgata*, Sieb., see p. 82 below.

53. E. SMITHII, R. T. Baker.

See C.R., XII., p. 76, Plate 55 (1910), but without a Victorian locality.

54. E. STELLULATA, Sieb.

See C.R., Part V., p. 127, Plate 25 (1904); F.F., Part XIV., p. 94, Plate 54 (1905).

55. E. STUARTIANA, F.v.M.

In C.R., Part XXI., pp. 4 and 6, I have explained that Mueller mixed up his *Stuartiana* very much, including no less than three distinct species under that name. *E. Bridgesiana*, R. T. Baker, is the third of these three, and I have pointed out (*op. cit.*, XXIV., p. 68) that the description of a species under another name does not remove the difficulties.

E. Stuartiana (*E. Bridgesiana*) is described at Part XXIV., p. 68, and Plates 101 and 102 (1915). Victorian localities at p. 69.

E. Stuartiana, F.v.M., as understood by Mr. Baker, is synonymous with *E. cinerea*, F.v.M. See my C.R., Part XXI., pp. 1 and 2, and Plate 89.

As regards *E. Stuartiana*, F.v.M., var. *cordata*, Baker and Smith, see my C.R., Part XXI., p. 5 (1914), where I state that it is synonymous with *E. cinerea*, F.v.M. (var. *multiflora*, Maiden). See Part XXI., p. 7, Plates 89 and 90.

56. E. TERETICORNIS, Sm.

See C.R., Part XXXI., p. 5, Plate 128 (1917).

57. E. TRANSCONTINENTALIS, Maiden.

As to Victorian localities, see C.R., Part XXXIX., p. 270 (1919) with the localities indicated at Part XV., p. 171.

58. E. UNCINATA, Turcz.

See C.R., Part XIV., p. 143, Plate 62 (1912).

59. E. VIMINALIS, Labill.

See C.R., Part XXVIII., p. 167, Plates 117-119 (1916).

E. VIMINALIS, var. PLURIFLORA, J.H.M. (Maiden).

Although I cannot trace this reputed variety attributed to me at the moment of writing, attention may be invited to my note of another variety, viz., *racemosa,* F.v.M., in *Proc. Roy. Soc. Tas.,* p. 90 (1918). The type appears to have come from Port Phillip, and I have given a number of Victorian localities in Part 64 of F.F.

60. E. VIRGATA, Sieb.

Synonymous with *E. Luehmanniana,* F.v.M. For a history of the confusion of this shrub (or very small tree) with *E. Sieberiana,* F.v.M., see C.R., Part XXXIX., p. 283 (1919); with C.R., Part IX., figs. 1 and 2, Plate 43; also Plate 44 (as *E. Luehmanniana*).

61. E. VIRIDIS, R. T. Baker.

This will be found figured and described as *E. acacioides,* A. Cunn., in C.R., XI., 45, figs. 9-12, Plate 52 (1910), and in my F.F., Part XLVIII., Plate 180 (whole plate), but I have since satisfied myself that Cunningham's material is mixed.

62. E. VITREA, R. T. Baker.

See C.R., Part VI., pp. 150 and 164, and Part VII., p. 189, with Plate 34 (1905); F.F., Part XXIII., p. 39, with Plate 86 (1906). See also *Journ. Roy. Soc. N.S.W.,* LII., 516 (1918), in which I try to clear up its relations to *E. vitellina,* Naudin.

For notes on Victorian localities see a paper by myself in *Journ. Roy. Soc. N.S.W.,* LII., 517 (1918).

Excluded Species.

In some cases it may be almost confidently predicted that they will be found to occur in Victoria, but it is best, in a list like this, to admit none without absolute proof.

E. amygdalina, Labill.

See C.R., Part XXXVIII., p. 227 (1919), where I agree with Messrs. Baker and Smith that the original species appears to be confined to Tasmania. At the same time it should be looked for on the Victorian coast. For the *E. amygdalina* as understood by Bentham, Mueller, and other botanists, see C.R., Part VI.

E. capitellata, Sm.

For many years I concurred in the general opinion that this species, originally described from Port Jackson, extended to Victoria. See my C.R., Part VIII., p. 211, with Plate 37, in part (1907). I am now of opinion, as expressed in Part XLV., p. 147, that it does not extend to Victoria, and that some of the Victorian specimens are referable to *E. Blaxlandi,* Maiden and Cambage, *Journ. Roy. Soc. N.S.W.,* LII., 495 (1918).

E. dealbata, A. Cunn.

See C.R., Part XXXII., p. 48, Plates 134, 135 (1917). At p. 49 I have stated that it has been recorded from Albury, but the specimens are not quite satisfactory, nor are the Tumbarumba ones normal. Although these localities (especially the former) are close to Victoria, they make one pause before inferring that, on this evidence, the species occurs in Victoria. Professor Ewart tells me that he cannot find any trace of this specimen (quoted by Mr. Baker; C. Walter was an old collector of Mueller's); "all our records for *dealbata* are from New South Wales localities only." I cannot therefore accept it as a Victorian plant at present.

E. fasciculosa, F.v.M.

The history of the confusion of this species with *E. paniculata,* Sm., is given at C.R., Part XIV. p. 140, with Plate 61 (1912). It is not a Victorian plant, so far as we know.

E. paniculata, Sm., is not a Victorian plant, in spite of my reference to it in C.R., XIII., 106, following Mueller. Mueller's record is from Gippsland, a very unlikely locality for *E. fasciculosa,* F.v.M., which see.

Those who desire to see a figure of this species will find it in F.F., Part VIII., Plate 30 (1904).

E. HAEMASTOMA, Sm.

I do not know of a Victorian locality.

E. PIPERITA, Sm.

See C.R., Part X., p. 299, Plate 45 (1908). As regards its claim to be a Victorian species, see pp. 300, 302, 304. I think it is a doubtful Victorian plant at present. See also F.F., Part XXXIII., p. 38, Plate 124 (1909).

E. POPULIFOLIA, Hook.

An excellent Victorian Eucalyptus observer, Mr. Harry Hopkins, says in "Advance Australia," for October, 1909: "Another species not common in Victoria, but which extends eastward through New South Wales and to Queensland, according to von Mueller, is *Eucalyptus populifolia*—the poplar-leaved or shining box tree. I have not seen it west of the Tambo River." He has sent me specimens from Orbost and the Tambo River, whose foliage simulates that of *E. Baueriana* a good deal. Although I reject it as a Victorian plant on the evidence, I somewhat confidently look forward to its collection in the Mallee country, or north-west.

For a figure of *E. populifolia* see my F.F., Part XLVII., Plate 176 (1912).

E. STRICTA, Sieb.

See C.R., Part XL., p. 336 (1920). It has not been proved to be a Victorian species so far.

E. WOOLLSIANA, R. T. Baker.

The Seymour plant is, I am satisfied, *E. hemiphloia,* var. *microcarpa.* As I am of opinion, already expressed in C.R., Part XI., under *E. odorata* and *E. hemiphloia,* that *E. Woollsiana* is a mixture of species, and as a full explanation requires additional figures, it cannot be fully dealt with at this place. It will be dealt with in Part XLVII., C.R.

[Proc. Roy. Soc. Victoria 34 (N.S.), Pt. II., 1922.]

Art. XI.—*The Rotifera of Australia and their Distribution.*

By J. SHEPHARD.

[Read 8th September, 1921.]

Investigation into the Rotiferon Fauna of Australia has so far been carried on by but few observers, but at widely separated points. The neighbourhood of Melbourne has probably received most attention. About Sydney, Brisbane and Adelaide collecting has been done, and outside these capitals scattered districts in Victoria and New South Wales have been worked, the most remote contribution being a colonial form obtained by Sir Baldwin Spencer when with the Horne Expedition to Central Australia.

It is quite true that the number of species of rotifers attributed to any country are so far proportionate to the amount of search that has gone on. It appears that much more work should be done before a full comparison can be made with the rotiferon fauna of other countries.

The time when an extensive investigation into this group of animals will be completed appears so remote that it may be useful to report progress in the hope that further enquiry may be stimulated. Adhesion to the classification of Hudson and Gosse, as the generally accepted one up to the present, seems desirable in spite of a recent proposed alteration. It may be well to point out that a departure from this system and of the accompanying understanding not to go back beyond Ehrenberg in the search for priority, will certainly retard work in this group in the outlying parts of the world, although such course may be in accordance with a strict interpretation of the rules relating to priority of names.

The records which may be regarded as reliable give a result in numbers as follows:—

Rhizota	39 species	of 9	genera.
Bdelloida	54 „	„ 16	„
Ploima—			
Fam. Illoricata	57 „	„ 17	„
„ Loricata	79 „	„ 19	„
Scirtopoda	1 „	„ 1	genus.

In all there are 230 species.

Many more species have been seen, but the above can be regarded as the total number of certain identifications, and is the work of some seven or eight observers.

The habitat and occurrence of rotifers in Australia present features differing from those of Europe and America. The dryness of the country in the summer months obliterates nearly all the pools in the early spring, so that the summer is the quiescent period for rotifers. The so-called "winter egg" which in Europe carries the species over the cold season is here a "resting egg" bridging over the warm weather. In the district south of Melbourne, known to botanists as the "heath country," there is an area with a surface largely formed of blown sand, in the hollows of which numbers of pools exist in winter and disappear entirely every summer, yet they yield a varied collection of these animals. Among the forms occurring in this way are a few species of unique characteristics which so far are unknown elsewhere. These all belong to the genus *Lacinularia*.

In the main part of Hudson and Gosse's "Rotifera" only one species of this genus was mentioned—*L. socialis,* a world-wide form—and in the supplement to the work there was a brief description of *L. pedunculata,* an Australian animal. Since the appearance of that work, eight more species of *Lacinularia* have been described, and of these seven, *L. elliptica, L. elongata, L. megalotrocha, L. pedunculata, L. racemovata, L. reticulata,* and *L. striolata* are from specimens found in Australia, and the remaining one, *L. natans,* Mr. Rousselet states, was found near London once only. This species is, however, extremely plentiful in Victoria, and has been found plentifully near Brisbane. Of these species two, *L. elliptica* and *L. elongata,* were recorded later from South Africa and France respectively. This still leaves five species unknown outside Australia. All these eight species of *Lacinularia* are colonial forms, and are therefore conspicuous and easily found, the smallest clusters being discoverable by the naked eye, while two, *L. pedunculata* and *L. striolata,* form clusters of thousands of individuals, and are objects as readily discernible as a fallen wattle flower, and a third, *L. reticulata,* occurring as it does in colonies on the surface of the mud, has been seen in masses over a square inch in area.

Mr. Rousselet in his paper on the "Geographical Distribution of the Rotifera" states that "it is not possible to speak of any typical or peculiar Rototorian fauna for any continent, zone or region." I submit that in view of the facts now stated in regard to the genus *Lacinularia* and its mode of occurrence, this decision is premature. There can be no doubt that man's activities are efficient agencies for the distribution of rotifers, and may largely account for the wide diffusion of species now observed, but, if isolated occurrences of the five species described and recorded solely from Australia should be discovered, it seems reasonable to regard them as most probably due to those agencies.

As above stated, the forms are conspicuous, and besides all appear in enormous numbers at times. The free swimming colonies fill the pools, it being impossible to dip an ounce of water free from them. The method of development indicates adaptation to the peculiar climatic conditions. The resting eggs, having lain dormant throughout the summer in the dried mud in hollows, on the fall of rain in early winter develop simultaneously with the eggs of other animal and vegetable organisms. Generally, the plant forms are the first to mature, and thus a supply of food is ready for the swarms of minute animals which follow. The early part of the wet season is the time when in a given pool a particular species often predominates almost to the exclusion of all others. This is specially noticeable in the five species, *L. elliptica, L. elongata, L. striolata, L. natans,* and *L. reticulata.*

L. striolata practises a unique method of multiplication of colonies, which strongly suggests a special adaptation to the environment. The clusters are sedentary, being attached by a peduncle to aquatic plants, and a single colony may consist of thousands of individuals. The growth of the colonies in this species is not due to successive generations of individuals taking their places in the colonies alongside their parents. The method is as follows: After the rain forms a pool the resting eggs of the previous season germinate, and give rise to free swimming individuals, which come together and form small colonies. Immediately in these colonies, the individual members of which are all females, parthogenetic eggs appear, and hatching out in the gelatinous nidus, the newborn rotifers swim away and combine with similar forms from other colonies to form a new cluster; thus a colony consists only of the animals which initiate it, and the colonies become successively larger as the increase in number goes on. This swarming process goes on until the food supply is exhausted, and at this stage males appear, followed by the formation of resting and presumably sexual ova, these latter being destined to endure throughout the summer until another rainy season again originates the process.

In view of these facts of adaptation to the special conditions of the Australian climate, the so-far exclusive occurrence of the majority of species of one genus, and the methods of multiplication of so peculiar a character, it seems too hasty to assume that rotifers are entirely cosmopolitan in their distribution. At least it must be granted that there are indications of an approach to an indigenous character such as strongly marks the general flora and fauna of this continent.

[Proc. Roy. Soc. Victoria 34 (N.S.), Pt. II., 1922].

Art. XII.—*Local Rain Producing Influences under Human Control in South Australia.*

By E. T. QUAYLE, B.A.

(With Map.)

[Read 8th September, 1921].

In a previous paper the author has brought several lines of proof to show that various influences in Victoria were having a marked effect upon the rainfall. The chief of these were the substitution in the Mallee of crops and grass for the drought-resistant forest covering, and irrigation, both natural and artificial. One of the proofs relied upon was a map showing for all stations available the departures of the mean rainfall for the decade 1910-1919 from that of a standard 30-year period, 1885-1914. This appeared to show remarkably well the effects looked for, that is, all areas in lee of, or S.E. from one with increased cultivation or irrigation, showed a marked increase in the rainfall, up to 15 per cent. in the most favoured cases. But there were increases just beyond the Victorian border in South Australia for which no explanation was available. In order to see if any light might be thrown upon this, I undertook the task of analysing the South Australian rainfalls in the same way as I had already done those of Victoria and the southern and western parts of New South Wales. This revealed an area of marked rainfall improvement, lying south-east from Lake Torrens, and embracing more especially the eastern portions of the Upper North, where it ranged as high as 20 per cent. This area seems to be continuous with the Victorian areas of improvement, in which case we have a long strip lying north-west and south-east, stretching from the sources of the Murray to Lake Torrens, or at least to the highlands of the Upper North, giving a total length of over 600 miles. It was found too, that as in New South Wales, north from this area the rainfall had markedly decreased, deficiencies of 14 per cent. being common, and that to south-west, as in Victoria, the areas dependent mainly upon "southern" disturbances for their rains showed a very definite decrease. We therefore have in South Australia and New South Wales a belt of country some 250 miles long and 70 miles wide which has had during the decade, in spite of a general downward tendency elsewhere, a decided increase in its rainfall.

Another improved strip, again lying N.W. and S.E., and therefore parallel to that just defined, begins on the west side of Spencer Gulf at Waratta Vale, some 40 miles north of Port Lincoln, and includes the foot of Yorke Peninsula and the eastern half of Kangaroo Island.

In looking for causes for these rainfall improvements, it is evident that irrigation can be disregarded. No serious attempts at irrigation have been made in South Australia, excepting, of course, those now in progress on the Murray, which in any case could only help Victoria.

We have to consider, therefore, only the alteration in the surface; the substitution of crops or grass for Mallee scrub or other drought-resistant vegetation, and the variations in the water supplies of the great inland lakes. The settlement of the country has brought about considerable changes in these respects. Unfortunately I have so far been able to get but little direct information more than that contained in the Statistical Registers, which deal only with production.

It is interesting to note that in general where throughout the 30-year period, 1885-1914, land occupation was complete and but little progress shown in cultivation and stock raising, there is also no improvement in the rainfall in lee of the area. This applies to the southern half of the country between St. Vincent's Gulf and the Murray River. County Adelaide, for example, has been practically stationary from 1884 to 1918 as regards horses, cattle, sheep and the area under cultivation.

Going northward, we find Counties Gawler and Light have made only very trifling increases in stock, though the years 1909-18 show a 35 per cent, increase in the area under cultivation. The Lower North (lat. 33-34) also shows an almost stationary condition as regards stock, but considerable progress in agriculture, the increase in area amounting to nearly 60 per cent. There is a definite rainfall improvement of up to 9 or 10 per cent. in lee of these areas, or over a N.-S. strip of 120 miles long, and about 20 miles wide.

The Upper North (lat. 31½ to 33) was so badly hit by the droughts of 1895-1902, that its cultivated area declined from 800,000 to about 500,000 acres, or by nearly 40 per cent., and it also suffered stock losses from which it took many years to recover. Even yet this division, though showing rapid increase of late, carries scarcely more stock than in those early years, 1885 to 1890, and less than in 1891 and 1892. As regards the effects from growing crops, it is evident that this cannot be great, at all events in the Upper North, unless we take into account the greatly increased vigour of growth due to recently improved cultivation methods, and the use of fertilisers. These certainly tend to produce far more vigorous growth during the spring months, and favour later sowing.

A not improbable factor is, however, the clearing of the country, which improves convectional action, and therefore makes thunder-showers of more likely occurrence. In spite of the stationary or retrograde conditions of agriculture, the needs of stock have probably made progress in ring-barking and scrub-clearing continuous so that the area of cleared hilly country should be steadily increasing.

Influence of the Lakes.

The foregoing are probable contributory factors, but the lie of the area of greatest rainfall improvement points distinctly to Lake Torrens as its chief origin. With regard to the state of this Lake or of L. Frome, which should share the same fortune, I have been able so far to get little definite information, though various people, some with 40 or 50 years' experience of the interior, most of whom were interviewed by Mr. Bromley, the State Meteorologist, have contributed their impressions. All agree that Lakes Torrens and Frome are rather immense salt pans than true lakes, and only rarely show any extensive areas of water surfaces. Mr. Price, of Frome Downs, writes as follows: "There are about 20 big creeks which, after rain in Flinders Range, empty into Lake Frome. This water all disappears in a few hours after the creeks cease running. The Lake is always very boggy, and no animal can cross it." Lake Torrens appears to behave much in the same way.

It would seem then that the water discharged from time to time into these depressions goes to dilute a semi-liquid mass, the water constituent of which being intensely salt and of high specific gravity, is capable of holding in suspension, and also preserving much of what the creeks, when flooded, bring down. The rate of evaporation would naturally be influenced by the amount of dilution. The lake beds could hardly remain at all porous, and owing to the absence of vegetation and animal life, either within the lake area or on the shores, the choking of the pores must be permanent. That is, the fine muddy particles have brought about the condition aimed at by the Mallee farmer who "puddles" his dam. Lake Eyre, being fed from such vast areas, is more truly a lake, and, according to Mr. Allen, of Warrina Station, is now fairly full, but that happens only rarely. Mr. T. Hogarth, who has had 50 years' experience of the district, has only seen the Lake filled twice during that time. It also forms such a boggy environment as to make the water unapproachable under ordinary conditions. This and mirage effects make it hard to ascertain the state of this or any of these lakes.

Run-off Improving.

It seems highly probable on various grounds that both Torrens and Frome are now impounding much more water than formerly. Experiences in Victoria go to show that settlement is effecting great changes in the run-off from the various river drainages. The clearing off or killing of the timber has made the springs better water providers, and the destruction of the trees, coarse grasses, reeds, etc., on the stream banks has caused the channels to deepen. Forty or fifty years ago the upper portions of the Avoca River and its tributaries consisted of shallow, and often grassy, channels, connecting large, deep water holes, providing permanent reservoirs, and through their large total capacity presumably holding back very considerable quantities of water which otherwise would have been poured on to the lower plain country. These water holes provided a paradise for anglers, especially school boys. They now hardly exist. Deep gutters have been cut from pool to pool, and the final result is a thread of water, almost constant in volume, with scarcely a pool of sufficient magnitude to shelter a decent sized fish. There is, of course, some compensation in the fact that the more permanent flow of the springs, the better protection from the sun, and the lessened demands of riverside vegetation cause more water to reach the river's final destination, and I anticipate that these factors are operating in connection with the lakes of South Australia.

Mr. W. E. Abbott, of Wingen, New South Wales, in various papers read before the Royal Society of New South Wales, has given many emphatic proofs of the effects of ring-barking in increasing the flow from springs, and making permanent the flow of streams previously only intermittent.

The Willochra Creek.

The chief source of water supply for Lake Torrens seems to be the Willochra Creek, which drains a belt of country extending south as far as Booleroo, and north as far as Hawker, two stations about 70 miles apart. The area of this can hardly be less than 2000 square miles. It is, of course, rather a dry area. the average annual rainfall ranging from 12 inches at Hawker, to 16 inches about Booleroo, but is liable to have quite a wet climate for months at a time. For instance, at Booleroo periods of six months' duration in 1916 and 1917 gave 17½ and 15 inches respectively; 5 months gave 12 inches in 1920, and 13 inches in 1921; 4 months in 1909 gave 13 inches; 3 months gave, in 1889, 12½ inches; in 1893, 11.6 inches; in 1908, 10 inches, and so on. Hawker has similar records: 14 inches in 3 months in 1889; 13 inches in 4 months in 1892; 15.2 inches in 5 months in 1916; 13.3 inches in 4 months in 1917; 20.4 inches in 6 months in 1920; and 14 inches in the first 5 months of 1921. These are quite sufficient to turn the creek into a very considerable river during these periods.

"Run-off" Rains.

Failing actual data, I ventured on an estimate of the variations in the water supply of Lake Torrens, based upon the probable run-off from the Willochra Creek basin, using the rain stations Booleroo, Quorn and Hawker. This required some assumptions of a very general character. The basin being well drained, I adopted as "run-off" falls in winter, anything over 2 inches for the first month, and 1½ for each consecutive month following, and in summer 3 inches for the first month, and 2 inches for each following month. This probably errs on the side of moderation, for falls of 2 or 3 inches are not uncommon in one day, but at all events it provides a fairly definite scale by which to compare the periods. The first really wet period was from

1889 to 1893, giving a total "run-off" rain of 31.0 inches. This was followed by a long dry spell of 12 years, 1894 to 1905, giving only 15½ inches altogether. The drought ended in 1902, but the "run-off" rains for 1903 to 1905 were small, only totalling 6.0 inches. From 1906 to 1910, a wet period, the "run-off" was 21½ inches; from 1911 to 1915, a very dry five-year period, only 2.4 inches; from 1916 to 1917, two very wet years, 15.7 inches; from 1918-1919, only 1.4 inches, and during 1920, and up till May, 1921, a very wet period, 17.0 inches. The lake should, therefore, have been large in 1894, and, say, 1895, in 1911 and 1912, and in 1918 and 1919. At the present time it should contain more water than at any time "within the memory of the oldest inhabitant."

Droughts Minimised by Evaporation from Lakes.

In order to see if the records tend to confirm the theory that the evaporation from Lake Torrens is a large factor in bringing about the improved rainfall to south-east, or in lee of it, and between the lake and, say, Wentworth and Mildura, I tabulated the annual rainfalls at ten of the principal stations in this area, as well as at five to southwards, where no improvement is evident, and of five to northwards beyond the influence of Lakes Torrens and Frome as rain producers. The first (Group A) consists of Hawker, Warcowie, Holowiliena, Wilson, Belton, Paratoo, Yunta, Cavenagh, Johnburgh and Waukaringa; the second (Group B) of Port Augusta, Quorn, Wilmington, Arden Vale and Port Germein; the third (Group C) of Blinman, Beltana, Mt. Lyndhurst, Leigh's Creek and Wooltana. The percentage departures from the average rainfall during the years following periods of lake water accumulation were as follow:

	1894	1895	1911	1912	1918	1919
Group A.	+19	−4	+7	+13	+2	+12
,, B.	+2	−18	−23	+10	−19	−3
,, C.	+1	+13	−3	−16	−25	−22

These figures show the apparent advantage to Group A from lake evaporation to be very marked, and they also show that the gain so striking during the decade 1910-1919 could not be attributed to the accidental excesses of wet years. The fact that owing to its position, Group B should have the most reliable rainfall gives the comparison additional significance.

Lake Frome.

This lake, when full, perhaps does not cover more than half the area of Lake Torrens. It is, nevertheless, then a very large body of water with a surface of greater extent even than Port Phillip Bay. It is filled from practically the same drainage area as Lake Torrens, and, therefore, should behave in much the same way. Unfortunately, there are no stations at all near it on the south-eastern side. About twelve miles due south from it, however, there is Frome Downs Head Station, which shows an increase of 27 per cent. for the decade 1910-19, over its average rainfall of 5¾ inches. At a radius of about 100 miles in a south-easterly direction are Boolcoomatta, Cockburn, Thackeringa, Broken Hill, Purnamoota, Poolamacca and Corona. These stations had in only two cases complete records for the period reviewed, but these records were capable of being "patched" without any large probability of error. All but one show marked improvements in the last ten years' rainfall, the percentages being respectively: +9, +11, —5, +13, +4, +3, and +23. The minus result was the most doubtful; but taking a mean of the lot, we get an average increase of 8 per cent.

Other Systems.

As regards the probable water accumulation in Lakes Eyre and Gairdner, or in the numerous minor lake beds of South Australia, nothing can at present be said. Lake Gairdner is probably under somewhat similar influences, but Lake Eyre derives its supplies from sources too remote, and an area too vast to permit of any hasty generalisation. It may be noted, however, that in connection with all these lakes there are indications of benefit during the decade 1910-1919 for all stations within areas south-east from them, and to some extent to south and south-west from them also. This, of course, is in accordance with results already shown by the analyses of the rainfalls on the eastern and western shores of the head of Spencer Gulf. Both gained from the waters between, but only in the case of the former could any great inland gain be expected, the general drift of the atmosphere being eastward.

The Cultivation of Eyre Peninsula.

Reference has been made to the improved rainfall over the eastern half of Kangaroo Island, the southern half of Yorke

Peninsula, and at Waratta Vale, in the east of Eyre Peninsula. In view of the expanses of sea included, it might seem absurd to connect these areas and to attribute the rainfall increases to any land improvements, but it is nevertheless true that such would be quite in accordance with what has been already described for other regions. Waratta Vale lies south-east from an area which has undergone rapid improvement during the last decade. In 1890 the counties Flinders and Jervois could only show 23,000 acres under cultivation, and it was only in 1906 that 100,000 was reached, but from 1910 to 1918 the average cultivation acreage was over 320,000 acres. This means much clearing of Mallee scrub. In Yorke Peninsula, too, the increase was very marked, amounting to more than 200,000 over the average acreage from 1890 to 1900, or from about 130,000 to 350,000 acres. This latter has recently become, owing to the use of fertilisers and improved methods generally, one of the most important granaries of South Australia.

Cultivation in the South-East and East.

The most rapid development in South Australian cultivation during recent years is in the counties Albert, Alfred, Chandos and Buccleuch, south of the Murray, and adjoining Victoria. Prior to 1908 the cultivation was almost negligible, less than 100,000 acres altogether. In 1916 their total was over 670,000 acres. Any rainfall improvement due to this would, however, mainly affect the adjacent Victorian Mallee areas, most of which are at present quite undeveloped. It is more than probable, however, that the improved rainfall shown about and south from Lake Hindmarsh is due to that. Moreover, in the recently developed Mallee areas along the Murrayvale-Ouyen line, the rainfall has proved better than was expected.

Explanatory Notes.

The objection might be raised that the great length of the rain improvement strip S.E. from Lake Torrens is out of all proportion to the area of the lake. This may be met by remembering that there may be many re-evaporations and re-descents as rain of the moisture obtained from the lake. Every moistening of any area helps the rain prospects for that in lee of it. Another point is that the hours of most active evaporation and precipitation are not the same. Thunderstorm rains are heaviest and most frequent towards evening, and widespread rains of tropical origin seem to be helped by the atmospheric cooling during night-hours. Thus the effects of lake evaporation might be postponed for several hours, and be first felt one or two hundred miles away.

Map showing percentage departures of the mean rainfall of the last 10 years, 1910-1919, from that of the 30 year period, 1885-1914.

Rainfall Incongruities.

The apparently haphazard mixing of small plus and minus departures may often be due to difference in elevation and aspect of the rain stations used. For example, south from Lake Torrens and west from the Willochra valley is some fairly mountainous country on which the bulk of the rain would be caused by "southern" disturbances and accompanied by wind, whereas on the lower ground or in lee of the ranges, the rains would be more of "monsoonal" type. The latter would show the influence of the lakes, the former might not. Then, of course, we have to put up with the occasional neglect of the rain guage, observers' carelessness, varying faults in the exposure of the gauge, etc.

Evidences from Decennial Rainfall Maps.

In order that the decade 1910-1919 should not have to carry the whole burden of proof that rainfall is affected by changes in the surface of the country, I plotted the rainfall departure in similar fashion for each of the three decades, making up the standard period. The results are most interesting and quite in accordance with the theory.

1885-1894. Over the inland areas of South-eastern Australia, or east from a line joining Spencer Gulf, Lake Torrens and Lake Eyre, this was a remarkably wet decade. While this helped to fill the lakes in South Australia, and increased the floodings of the Murray and its tributaries, thus producing evaporation areas and increasing the rainfall in the favoured areas, the generality of the abundant rainfall, which was largely of direct tropical origin, tended to obliterate these local preferences. We can look, therefore, for smaller percentage gains over the areas usually favoured. This shows up quite well on the map. The following strips of country showed less gain than the country on either side: (1) Along the Murrumbidgee from its junction with the Lachlan, almost up to Narrandera; (2) From Yarrawonga to Deniliquin and Piangil, or along the upper Murray and Edwards; (3) From Shepparton, along the Murray to Wentworth; (4) From Wentworth to Lake Torrens. As regards the river areas, this tends to confirm the reality of the rainfall increases shown by the isohyets on the average annual rainfall map to obtain along the Murray and the principal streams through the Western Riverina. When the map was constructed, in 1910, this was regarded as a freak result. The actual percentage departures from average are as follows. Beginning with the plain country north of the Murrumbidgee, and ending with the Victorian plain country south from the Murray River we get: Plains (northern) +28, Murrumbidgee River +19, Plain +24, Edwards and Murray River (upper) +20, Plains +23, Murray River (lower) +17, Plains (Victoria) +24.

For the decade the greatest percentage increases are over the north-west and central plain country of New South Wales, where some reach 40 per cent. The dominantly tropical origin of the rains is obvious.

Stations along the Darling from Pooncarie to Wilcannia show very consistent increases of over 30 per cent., which may have been partly due to the filling of the rarely filled lake system along the Darling.

1895-1904. Drought was predominant during this decade, and tropical influences on the whole ineffective. The very severe three years' drought which began in July, 1895, must have dried up the moisture in the lake beds, and there was no appreciable run-off to renew it until 1903. This being so, we should look for the area partially dependent upon the lakes for its rainfall to show the greatest deficiencies during this period. This is shown very well, the minus isopleths for this decade showing much the same contouring as the plus for 1910-1919. This reversal is even shown along the southern and south-eastern borders of the Mallee, which is at it ought to be, the Mallee still being largely wilderness or unimproved.

1905-1914. This being a transition period, both for agricultural development and lake storage, its isopleths do not stand out as those for 1910-1919, but similar tendencies are strikingly shown. The agricultural progress of Eyre Peninsula is apparently reflected in rising rainfall to south-east of the areas, that is, on the foot of Yorke Peninsula and the eastern end of Kangaroo Island; the Western Wimmera is gaining by the clearing and cultivation of the South Australian Mallee across the border; and the rainfall from Wentworth to Lake Torrens is distinctly on the up grade.

It supplies, moreover, another exceedingly neat proof of the effectiveness of the floodings from the Murray River system in increasing the rainfall on the river flats, the rainfall isopleths over the Riverina and northern Victoria, which were minus, giving an almost exact copy of those for the wet decade, 1885-1894, which of course were plus.

All three decades thus bring their evidence to support in various ways the theory that the rainfall is largely affected by local influences. The coincidences in areas affected are very striking.

Another point made clear is that the decennial rainfall oscillations are far greater east from the South Australian lake system than west of it, which is itself fairly strong evidence that the variation in the lake supplies is a large disturbing factor. The figures also suggest for inland New South Wales a rainfall dependence upon previous downpours in Queensland, and especially those tending to fill Lake Eyre.

The following table shows the decennial rainfall variations at two groups of stations, one on the western, the other on the eastern side of the lake system:—

Western Group.	1885 to 1894.	1895 to 1904.	1905 to 1914.	1910 to 1919.
Oodnadatta	+5	−1	−4	−15
Anna Creek	+0	−8	+9	−9
William Creek	−10	+2	+8	−12
Stuart's Creek	+5	−14	+8	−1
Arcoona	+5	−3	−2	−5
Coondambo	+1	−9	+8	+2
Means	+1	−6	+4	−7
Eastern Group.	**1885 to 1894.**	**1895 to 1904.**	**1905 to 1914.**	**1910 to 1919.**
Warcowie	+11	−19	+8	+11
Holowiliena	+13	−25	+13	+23
Belton	+14	−24	+10	+11
Paratoo	+19	−32	+13	+20
Frome Downs	+14	−31	+18	+27
Cockburn	+21	−20	−1	+11
Means	+15	−25	+10	+17

Seasonal Forecasting.

The effect on this cannot be ignored, since well-filled lakes are a guarantee that for a few years, two at least, the climate of the areas south-east from them will be greatly ameliorated—this can be taken account of by farmers and pastoralists, the latter more especially. For example, whatever the severity of any general drought over south-eastern Australia during the next two years, its effects should be distinctly alleviated over a large area south-east from Lakes Torrens and Frome, as well as over all northern Victoria, and some of the Riverina.

General Deductions.

The strength of the preceding reasoning lies, of course, in the general and striking accordance of the results obtained. Taken in conjunction with Victorian experience, these are so numerous that the case for definite rainfall improvements due to local sources may be regarded as definitely proved. It is the evidence we accept to demonstrate the rainfall effects of rising ground proximity to the ocean, prevailing winds, etc., for which we do not need many years' records. This solves the problem of what should be done to revive the "dead heart of Australia." Without any far-seeing policy or consciously-directed effort on our part, it is probable that the great inland lakes will gradually store more and more water; but surely the process is worth hastening. For example, it might even be worth while to keep Lake Torrens at least partially supplied from Spencer Gulf. An improvement of 20 per cent. in the rainfall of 20,000 square miles of country is worth much money, a practical example of which is to hand. The counties Granville, Hanson, Herbert and Lytton, which form only a part of the improved rainfall area under discussion, in 1918 carried 387,000 sheep and nearly 11,000 cattle and 4000 horses, numbers practically equal to those of 1891, the record stock year for Australia.

Storage Gains from Clearing.

The preceding study teaches two important lessons. One is that the clearing away of the forest covering from the whole of our hilly areas, at all events, of those portions of the inland foothills and mountain slopes in any way suitable for pasturage, is distinctly beneficial, not only to its stock-carrying capacity, but to inland climatic conditions as well, inasmuch as it greatly increases the amount and constancy of the flow of the rivers. It thus releases from day to day for storage in inland lakes and reservoirs vast quantities of water which otherwise would be thrown into the mountain atmosphere, and to a large extent cross the hills, eastwards and southwards, without condensation, and so escape. A reason for thinking this is that the transpiration and evaporation from the leaves of the upland trees must be little or none during the times of atmospheric saturation, but are probably most vigorous during the bright sunshine and drier air of the anticyclonic periods. This seems contrary to the behaviour of the drought-resistant vegetation of the plains, which has to adapt itself to extreme conditions, but it is not really so. By mountain vegetation, more especially that of Victoria and New South Wales, the strain of drought and heat is rarely felt and so definite drought resistance is not often called for; whereas saturated air is a rare experience to the Mallee eucalypts and their fellow strugglers, and heat and aridity so often have to be endured that transpiration, if not checked, would exceed the powers of their roots to make good. From the former, evaporation is inopportune, both in time and place—from the latter in time.

Need for a National Policy.

The other is that every facility should be given to settlers to make payable use of our remoter inland areas, even to the extent of national financial, and other sacrifices, recognising that this occupation of the interior is a sure way of ameliorating the climate for the rest of the continent or, at all events, for all those areas in lee of the outpost belt. Obvious methods are, of course, the adoption of some zone system for railway fares and freights, and the establishment of the greatest water schemes the continent is capable of. The addition of four or five inches of rain to the average annual rainfall of our dry areas, especially if the addition were maintained during drought periods, would mean multiplying their value by 20 at least.

It is evident, too, that the further inland the water can be stored or utilised, the more extensive will the area benefited climatically be.

Tropical Origin of Inland Rains.

Keeping Lake Torrens full would evidently help to keep Lake Frome full also, the latter draining a very large proportion of the country benefiting. If we consider the origin of these inland rains, and the processes at work in their production, this statement will prove not so extravagant as it seems at first sight. The mapping of the daily departure from normal of the minimum temperatures at all stations over the northern half of the continent shows that practically all the inland rains are of tropical origin. That is, rain never falls, say, in the neighborhood of Lake Frome without previous evidence of a drift towards this region of a body of relatively warm, moist air from some northerly point, most often, presumably, from the north-west. Condensation is usually the result of latitudinal cooling, and may take place without the assistance of any storm developments, though it most often occurs in the north-eastern front of "southern" disturbances which naturally accelerate the southward drift of the air in front of their troughs. It is occasionally helped too by what appears to be displacement upwards of this warm air by the cold, dry air of an anticyclonic system moving inland from some point south of west. But whatever the outside accelerating influences, it is certain that evaporation from any considerable body of water in the path of this southward-moving air will have a powerful effect in deciding where and when precipitation shall begin. Assuming, say, that we have, as these minimum temperature departures so often show, a wide flow of air coming inland from the neighborhood of Wyndham or Port Darwin, this may carry its water vapour without much addition from the dry plains beneath for perhaps 2000 miles before it shows by its cloud production that through gradual cooling the limit of its moisture-holding capacity is nearly reached. Precipitation may not begin till the Murray is reached, or even the highlands of the Divide, but it might begin considerably earlier, and perhaps two or three hundred miles further inland if it encountered the disturbing effect of buoyant, moist air rising from such a source as L. Eyre or L. Torrens. That is, for large inland areas, the influence of the lake evaporation helps to determine not only the amount of rain, but perhaps more often whether there shall be some rain or none. In a sense it may be partly a question as to when and where "the tap is to be turned on."

Australia's Increasing Aridity—a Partial Cause.

In these papers, reference has already been made to the different ways in which vegetation may affect rainfall. It has first been shown that the substitution of growing cereal crops or grass for Mallee scrub causes a marked increase in the rainfall of the districts in lee of the improved area, especially in spring. Then irrigation was proved to show some similar effects. And now I have been able to show greater effects still, from the recently increased water storages in the great lakes of South Australia, the benefits being almost on a continental scale. For the increasing lake water storage, the changing character of the natural drainage channels, and the lessening of the water demands of the forest covering under pastoral occupation have been shown to be important factors. We may now logically apply these results to the solution of a larger problem.

The early settlers in the eastern interior of this continent found inland perennial vegetation to consist first of a belt of vigorous growing trees with abundant foliage occupying the more elevated upland regions; next on the foothills and adjacent plains the hardier types of the same with smaller leaf surface; then further inland stunted and distinctly drought-resistant types, such as Mallee eucalypts, bull-oaks (casuarinas), etc.; and further inland still, under severer conditions, salt bush, blue bush, etc.

Now it is more than probable that in the struggle for existence our perennial vegetation has been its own undoing. The very means it has been compelled to take for its own protection have made the climatic environment progressively worse. Whether distinctly drought-resistant or not, it must regulate transpiration so that it is never unduly accelerated with the result that the hot spells leading up to rainy conditions find inadequate response in evaporation from the country beneath, while the comparative coolness of the shaded land surface helps to prevent convectional action and lessen the frequency of thunder-showers. Moreover, the blocking of the water channels and the prevention of erosion, the drying of the subsoil, and consequent lessened flow from springs owing to the large moisture requirements of the trees all tend to hold the water up against the eastern mountain slopes, where its evaporation is comparatively ineffective in rain production, and away from the depressions in the interior where its evaporation would be most effective in rain production. Hence the increasing dryness of the interior and the gradual contraction of the belt of perennial vegetation towards the inland slopes and foothills.

It therefore follows that pastoral occupation must be assisting to reverse the process of dessication. The destruction of the forest trees in the more favoured belts, and the substitution of grass and annuals for the more drought-resistant trees, and even for the scrub and herbage perennial growths inland, are aids in the local production of rain, while the firming of the surface soil and the formation of tracks to water by stock help to make surface drainage better. Then the tapping of artesian and sub-artesian water supplies, though probably only a minor influence, must help to increase atmospheric vapour supplies and tend to rain production. Much injury is in parts unfortunately being done to the fine surface soil covering of the plains, but where the plough is used this is arrested.

The filling of Lake Eyre though a most attractive proposition, is perhaps an impracticable one, but water storage and irrigation for large portions of the north-western and western divisions of New South Wales seem possible, and if carried out whole-heartedly, would surely have beneficial results to the inland climate of that State almost incalculably great. The addition of two inches of rain annually seems quite possible, and that would carry wheat cultivation westwards to the Darling River.

Proc. Roy. Soc. Victoria 34 (N.S.), Pt. II., 1922].

Art. XIII.—*The Development of Endosperm in Cereals.*

By MARY GORDON, B.Sc.
(Caroline Kay Scholar).

(With 9 Text Figures.)

[Read 13th October, 1921].

The early stages of endosperm development are accurately described in the text-books and other publications dealing with the subject; but it is assumed that the process of free cell-formation, by which the first layer of endosperm arises, is continued throughout the development of the seed, and that all the endosperm cells are formed by the development of cell-walls around the nuclei that lie freely in the protoplasm of the embryo-sac. The earlier stages in the development of the endosperm of Burmannia—a monocotyledon comparable with the cereals in endosperm development—have been described by Ernst and Bernard (1). They have shown that the nuclei formed by the division of the first endosperm nucleus, do not become immediately enclosed in cell-walls, but they line the embryo-sac, and later cell-walls develop between them. From this stage Ernst and Bernard did not trace the method of endosperm development any further; they apparently took for granted that all the endosperm was formed in a similar manner.

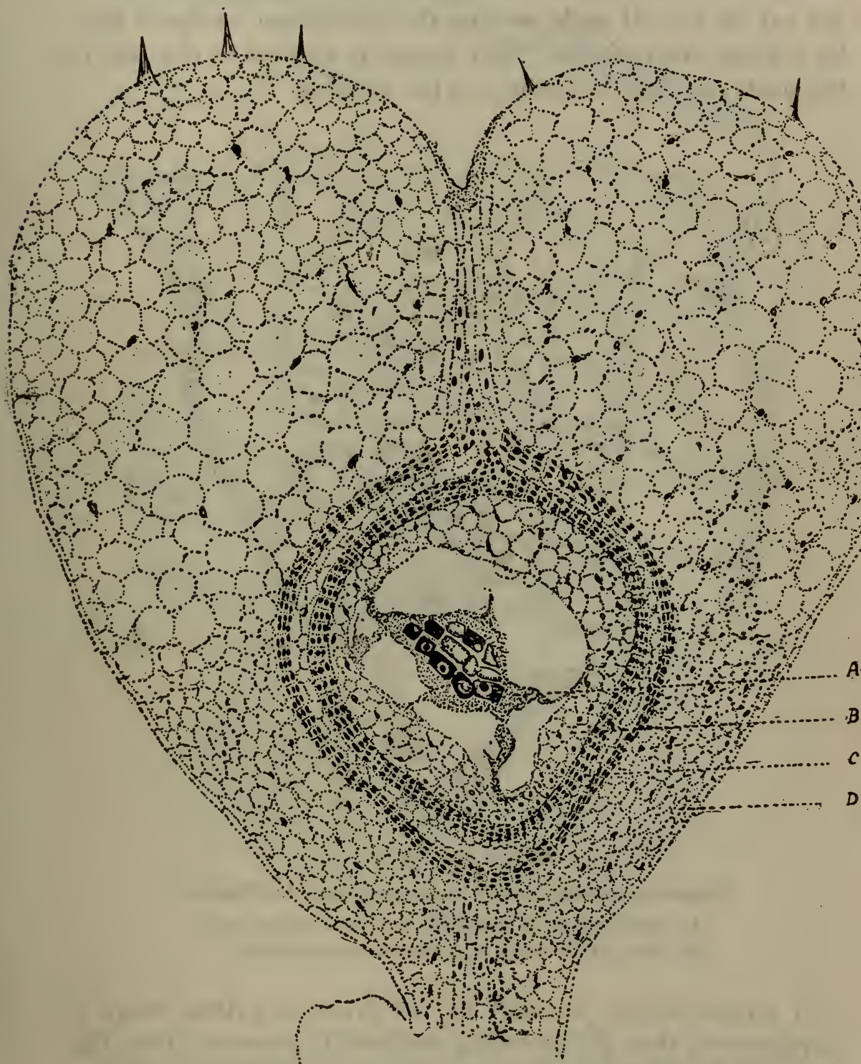
The mature grains of cereals agree in the main points of structure, having the bulk of the endosperm composed of large cells filled with starch grains, and a peripheral layer, or layers in the case of barley, containing no starch, but protein material in the form of aleurone grains. These cells also contain large nuclei, whereas the nuclei of the inner cells are much disorganised.

In a paper—The Endophytic Fungus of Lolium—published in the proceedings of the Royal Society of Victoria, Dr. McLennan (2) has described the outer layer of the endosperm of *Lolium temulentum* as an endospermic cambium, which is active only on its inner surface, where it cuts off brick-shaped cells which assume an approximately spherical form as they attain their adult size. They remain thin-walled and constitute the starchy endosperm. As the grain approaches maturity, the outer layer ceases to divide, but it persists in the seed as the aleurone layer. Even when the cells of this layer are resting, and have become filled with reserve food, their nuclei remain large and intact. At this stage the walls of the aleurone cells become considerably thickened, and this supports the cambium theory, since cambial cells entering on a period of rest show thickenings on their walls which are either partly or wholly removed when such a layer recommences its activities.

I have attempted here to trace the development of the aleurone layer and the starchy endosperm in the more common cereals, and to show whether the starchy endosperm is developed from the aleurone layer or not; that is, to prove whether the aleurone layer is really an endospermic cambium or not.

The ovules of barley, wheat and oats were taken at various stages of development, and fixed in either Carnoy's or Bouin's fixing solutions. Considerable difficulty was experienced in fixing the oat grains, owing to the hairy nature of the pericarp, which prevented the fixing solution from penetrating the seed. An attempt to fix some seeds under reduced atmospheric pressure was not any more successful, since the more volatile constituents of the fixing solutions tended to vaporise under the reduced pressure, and so pass out of the solution. The only way to ensure rapid and complete penetration of the fixing solution is to pierce the seed-coat, and even then the inner endosperm of ripe grains generally breaks in cutting. Microtome sections were cut of the grains embedded in paraffin, and the sections were stained with Haidenhain's Iron Haematoxylin as it rendered the nuclei in mitosis very distinct. In all three cases the development was found to be practically identical, except that the ripe barley grain has—as is well-known—an aleurone layer several cells deep, whereas wheat and oats have a single layer only. In the "Annals of Botany," Miss Brenchley has published two papers describing the earlier stages in the development of the grains of wheat and barley (3) and (4). They show how the first endospermic nuclei are formed by the division of the secondary nucleus of the embryo-sac, but the later stages in the endosperm development are not described.

A longitudinal section of a young ovary is shown in Text Fig. I.; it is not cut directly through the centre of the seed so that the embryo does not appear in the section. In the centre of the embryo-sac are the first-formed endospermic nuclei, which have been formed from the secondary nucleus after fertilisation. These appear as a group of free nuclei lying in the protoplasm of the embryo-sac. This, according to Goebel,



TEXT FIGURE I.

Longitudinal section of young ovary of barley after fertilisation.

A—First endospermic nuclei.
B—Nucellus.
C—Ovular integuments.
D—Wall of ovary—later pericarp.

4A

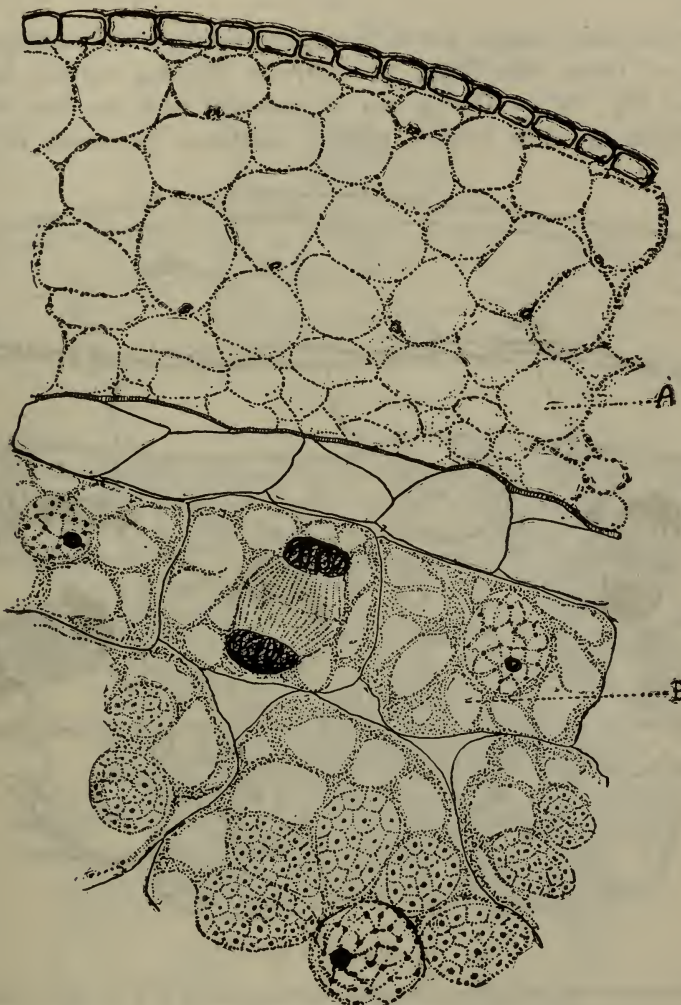
occurs in all monocotyledons and most of the dicotyledons. Some of the nuclei later pass to the walls of the embryo-sac, where they form a single lining layer (Text Fig. II.). Portions of the protoplasm around the walls, each containing a nucleus, are cut off by cell walls, so that the embryo-sac becomes lined by a single layer of cells. This section is also cut to one side of the ovary, so that the embryo is not showing.

TEXT FIGURE II.

Contents of embryo-sac of barley soon after fertilisation.

A—Group of large vacuolate nuclei in embryo-sac.
B—Wall of sac lined by protoplasm and nuclei.

A typical section through an oat grain in a later stage of development than the preceding sections is shown in Text Fig. III. One nucleus of the outer layer of endosperm cells is undergoing mitosis, and there are also two resting nuclei of the same layer apparent. After the nuclei divide, transverse cell-walls are formed between them, and the inner cells do not as a rule divide again, but they enlarge considerably and become filled with starch. The nucleus of the outer cell remains large and retains its power of dividing until the grain is almost mature. Aleurone grains then appear in the cells of the outer



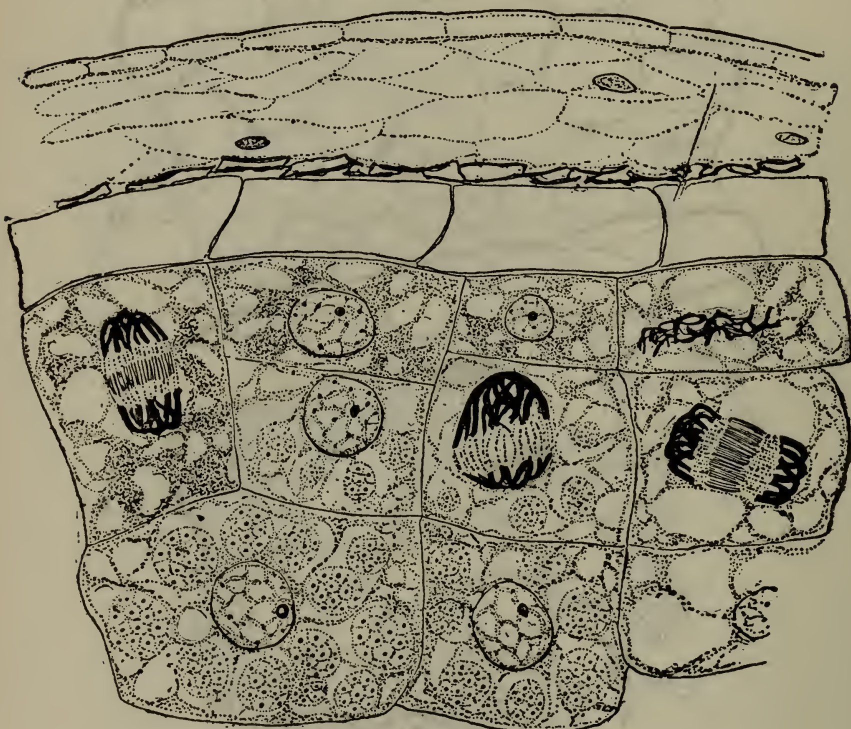
TEXT FIGURE III.

Transverse section of oat grain.

B—Endospermic cambium shows two resting nuclei and one in mitosis.
A—Degenerating cells of walls of ovary.

layer. The starch of the endosperm of oats is not in the form of grains as in wheat and barley, but appears as rounded groups. Each group is made up of a number of centres, of which there appear to be more in the older than in the younger groups; but it is possible that the number of centres is the same in all of the groups and only show up clearly when starch is deposited in them.

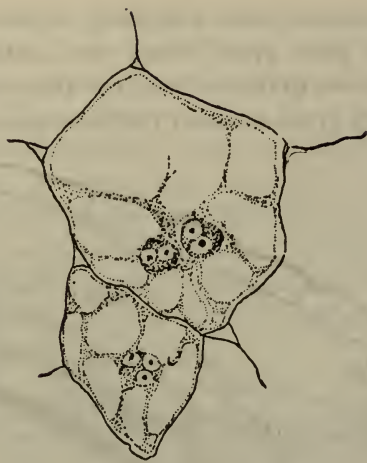
Occasionally nuclei are to be found dividing in the endosperm two or three cells below the actively dividing surface layer (Text Fig. IV.). This is not inconsistent with the idea of a cambium, as cells formed from a cambium frequently divide



TEXT FIGURE IV.

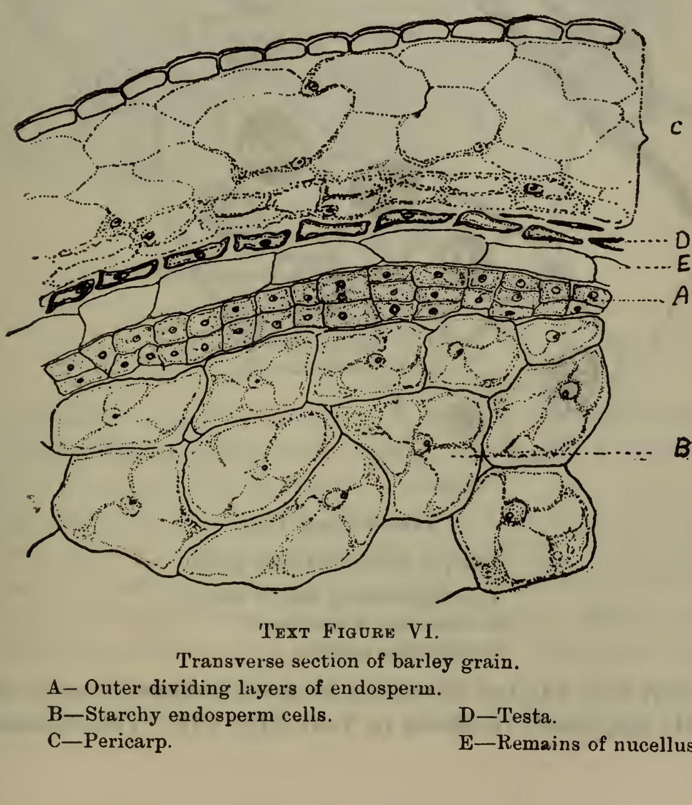
Transverse section of young oat grain showing nuclei of first and second layers in mitosis.

again. In the endosperm of barley binucleate cells sometimes occur (Text Fig. V.), and it is possible that after the original nucleus divided the two daughter-nuclei lie close together in the cell, and are prevented from separating by the presence of starch which soon becomes deposited in the cell. This also would prevent the formation of a new cell wall, thus giving a single binucleate cell.



TEXT FIGURE V.
Binucleate endosperm cell.

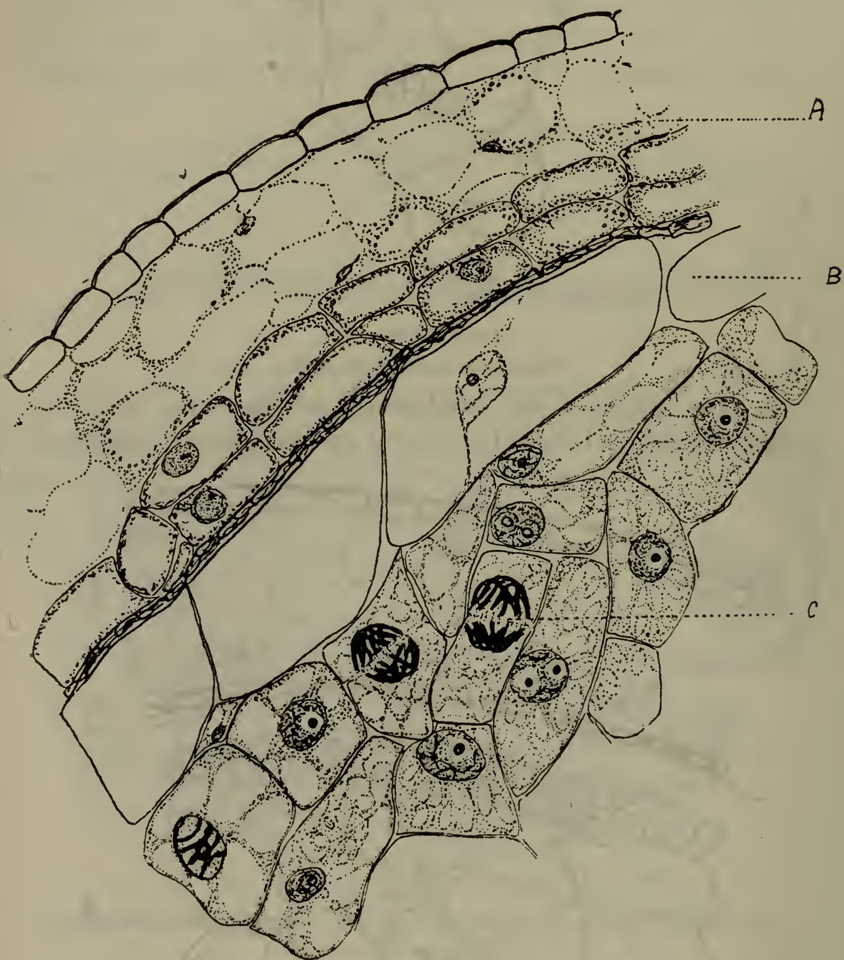
A later stage in the development of the barley grain is illustrated by Text Fig. VI.; it shows the transition of the surface



TEXT FIGURE VI.
Transverse section of barley grain.

A— Outer dividing layers of endosperm.
B—Starchy endosperm cells.
C—Pericarp.
D—Testa.
E—Remains of nucellus.

layers of the endosperm from a dividing cambium to the resting condition of the adult grain, when the cambial cells become packed with aleurone grains to form the aleurone layer. Another section of a barley grain at about the same stage of development



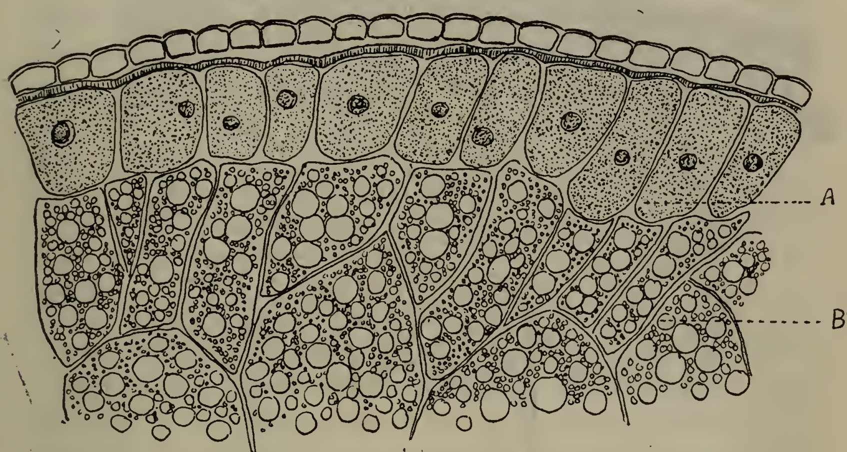
Text Figure VII.

Oblique section of barley grain.

A—Degenerating wall of ovary.
B—Remains of nucellus.
C—Dividing nucleus.

as Text Fig. VI., but which has been cut obliquely, and is more highly magnified, is shown in Text Fig. VII. The distinction between the dividing cambial layer and the general endosperm is not so well marked, but the details of cell-division are clear in the outer layer, which appears several cells deep owing to the obliqueness of the section.

Surrounding the endosperm there is a single layer of large cells, the contents of which have practically disappeared; this is the remains of the nucellus (5), which has been displaced and absorbed by the developing endosperm. It appears as a layer of disorganising cells in the young grain, but has disappeared when the grain is ripe. Beyond this there is a layer of silica, which



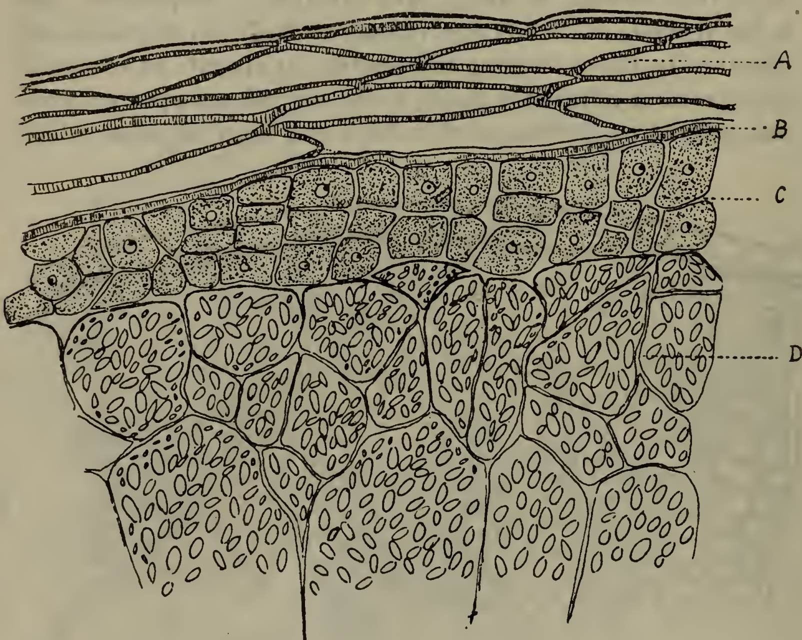
TEXT FIGURE VIII.

Transverse section of ripe oat grain.

A—Single aleurone layer.
B—Endosperm.

was probably deposited in the outer wall of the embryo-sac—this forms the so-called testa which is not really a seed-coat, since it is devoid of any cellular structure.

The ovary wall contained starch which was absorbed by the embryo during its development (Text Fig. VI). As the starch is used the cells become empty, and the nuclei can be seen in process of degeneration. Later the cell-walls thicken and develop into the pericarp of the ripe grain. The final stages, where the resting cambium appears as the aleurone layer, are shown in a transverse section of an oat grain (Text Fig. VIII.), and of a barley grain (Text Fig. IX.). With the exception of occasional cases in which dividing nuclei occur just beneath the superficial cambial layer, no cell divisions take place in the starchy portion of the endosperm, which is entirely derived from segment cells cut off from the cambium.



TEXT FIGURE IX.

Transverse section of ripe barley grain.

A—Pericarp.
B—Testa.
C—Aleurone layer several cells deep.
D—Endosperm (starch).

The fact that the aleurone layer differs from the starchy endosperm in being a resting layer, enables us to understand several of its peculiarities. Thus Stoward (6) has shown that the removal of the aleurone layer from the endosperm leads to a marked fall in the output of carbon dioxide by the grain, and indicates approximately the comparatively large share of the total respiratory output that is due to the aleurone layer. Injury to the seed alone would tend to cause an increased respiratory activity manifested as a wound reaction. Although the cells of this layer are packed with aleurone grains, they also contain large, well-defined nuclei and a quantity of protoplasm. The nuclei of the starch-containing cells of the endosperm are partly disorganised and the cells contain very little protoplasm. The greater respiratory activity of the aleurone layer may be accounted for if it is to be regarded as a resting cambial layer.

It has also been demonstrated that there is present in the outer layers of the endosperm of wheat, rice and other cereals, a substance the deficiency of which causes polyneuritis in birds and Beri-Beri in man (7). Funk gave to this substance the name vitamine, and supposed it to be contained in cells rich in protein. It is found in the tissue of the embryo of cereals, as well as in the aleurone layer, but it is deficient in the starchy endosperm. Since vitamines are usually especially associated with growing tissues, it is not surprising to find that in this layer—a resting cambial layer—they should be especially abundant, whereas in endosperm cells derived from it, which degenerate into starchy receptacles, vitamines should be deficient or absent.

Brown and Morris (8) advanced the view, from their experiments, that the amylaceous endosperm of Granineae represented a "dead storehouse of reserve material." This conclusion does not refer to the endosperm as a whole, but only to the amyliferous cells, the possibility of the aleurone cells possessing vitality being left open. Haberlandt (9) regarded the aleurone layer as a glandular digestive organ.

The following table, taken from the report of a committee of the Royal Society of London, indicates that there are vitamines present in the whole grain of the cereals, but the flour which is obtained after milling contains no vitamines, as they are removed with the aleurone layer.

VITAMINES IN PLANTS.

Plant.	Fat-soluble A (Antirachitic)	Fat-soluble B (Antineuritic (Anti Beri-Beri)	Unstable C Antiscorbutic
Wheat and whole grain of cereals	+	+	0
White wheat flour	0	0	0
Cornflour	0	0	0
Polished rice	0	0	0
Malted barley	+	+ +	+ +

Summary.

(1) The first formed endospermic cells of cereals are derived from the secondary nucleus of the embryo-sac.

(2) The nuclei so formed pass to the walls of the embryo-sac, when they form a lining layer. Later the nuclei become enclosed by cell walls, so that the embryo-sac is lined by a single layer of cells.

(3) The lining layer of the embryo-sac assumes the character of a cambium, which produces segment cells only on its inner surface.

(4) The segment cells formed by the division of the cambial cells enlarge, remain thin-walled, and become packed with starch, to form the starchy endosperm.

(5) After the cells of the endospermic cambium have ceased to divide, they become filled with aleurone grains and the cell-walls thicken. It then forms the aleurone layer.

(6) The greater respiratory activity of the aleurone layer and the presence of vitamines in it are the natural results of its being a resting cambium.

(7) Whether it can be awakened to further activity during germination remains for future investigation.

The foregoing research was carried out in the Botanical Department of Melbourne University, under the direction of Professor Ewart, and represents the work done as Caroline Kay Scholar.

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(8) Brown and Morris—Journal of the Chemical Society, vol. lvii., 1890, p. 458.

(9) Haberlandt—Physiological Plant Anatomy.

Proc. Roy. Soc. Victoria 34 (N.S,), Pt. II., 1922].

Art. XIV.—*Present and Probable Future Distribution of Wheat, Sheep and Cattle in Australia.*

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(Communicated by A. E. V. Richardson, M.A., B.Sc.)

(With 3 Text Figures.)

[Read 10th November, 1921].

Australia being essentially an agricultural and pastoral country, it was thought that considerable interest would attach to any method which would graphically and accurately represent the distribution throughout the continent of the units of the main primary industries; further, that such might give some insight into the possibilities of extending the various industries beyond their present boundaries, and the direction in which such extension is likely to take place. With this object in view the accompanying maps were prepared, showing the distribution of the units of the three principal primary industries—viz., sheep, cattle and wheat—in Australia (referring here and in all statistics to the continent of Australia, excluding Tasmania). The method adopted has been to represent a certain number of head of stock, or acres of wheat, by a dot placed on the map as near as possible to their situation, as indicated by official statistics; this gives a more accurate representation of the distribution than can be obtained by differential shading or coloring. Each dot represents respectively 5000 acres of wheat, 10,000 head of sheep, and 1000 head of cattle; these quotas are small enough to show a relatively sparse distribution, yet without showing too great an area where the dots run together, and no differentiation can be shown in the areas of concentration of the respective units. The statistics used were those for the year 1918-19, being the latest typical season for which details of all the States were available at the time the work was commenced. Similar maps have been prepared by the United States Department of Agriculture, but it is hoped that so far as Australia is concerned those now published are not only based on later records, but more accurately represent the actual distribution of the units throughout the country.

Embodied in the maps is also meteorological data relating to rainfall and temperature, which is necessary for adequate consideration of the factors affecting the present distribution and probable extension of the industries. The data given consist of various isotherms (i.e., lines of equal average mean annual temperature) with the 5, 10, 20, 30, 40 and 60 inch isohyets (i.e., lines of average annual rainfall), in the case of the two stock maps; and for the wheat map, the 5, 7.5, 10, 15 and 20 inch lines of winter rainfall, or more strictly the rainfall during the growing period of the crop, i.e., April to October, inclusive.

Acknowledgment is here made to the Government Statists of the various States and the Department of Home and Territories for the furnishing of the statistics necessary to the work, and to the Commonwealth Meteorological Bureau for meteorological data used.

Wheat.

The total area sown to wheat for grain and hay in Australia, for the season 1918-19, was 9,647,433 acres, and of this total New South Wales contributed 3,227,374, South Australia 2,571,208, Victoria 2,488,810, Western Australia 1,336,502, and Queensland 23,539 acres. This area represented approximately 3.5 per cent. of the total area that year sown to wheat throughout the world. Until the last four seasons, which have shown a decline due to abnormal labour and marketing conditions, there had been a steady expansion of wheat-growing in Australia, her production increasing from 1.6 per cent. of that of the world in 1906-07, to 4.8 per cent. in 1916-17, and it is hoped to show that there is ample room for this extension to continue.

Considering the distribution of the area shown by the map (Plate I.), the most striking feature is the very limited extent of the wheat-growing country. There is, indeed, a distinct wheat belt forming a crescent-shaped area some distance inland from, and approximately parallel to, the south-eastern coast line, approaching and broken by the coast line as the latter turns northwards along South Australia, and continued again as a similar belt back from the south-western coast of Western Australia.

The factors limiting the distribution of the wheat acreage may be classed under two heads—natural and political or economic. The chief natural factors are the soil and climatic conditions of rainfall and temperature. The soil within any climatic region

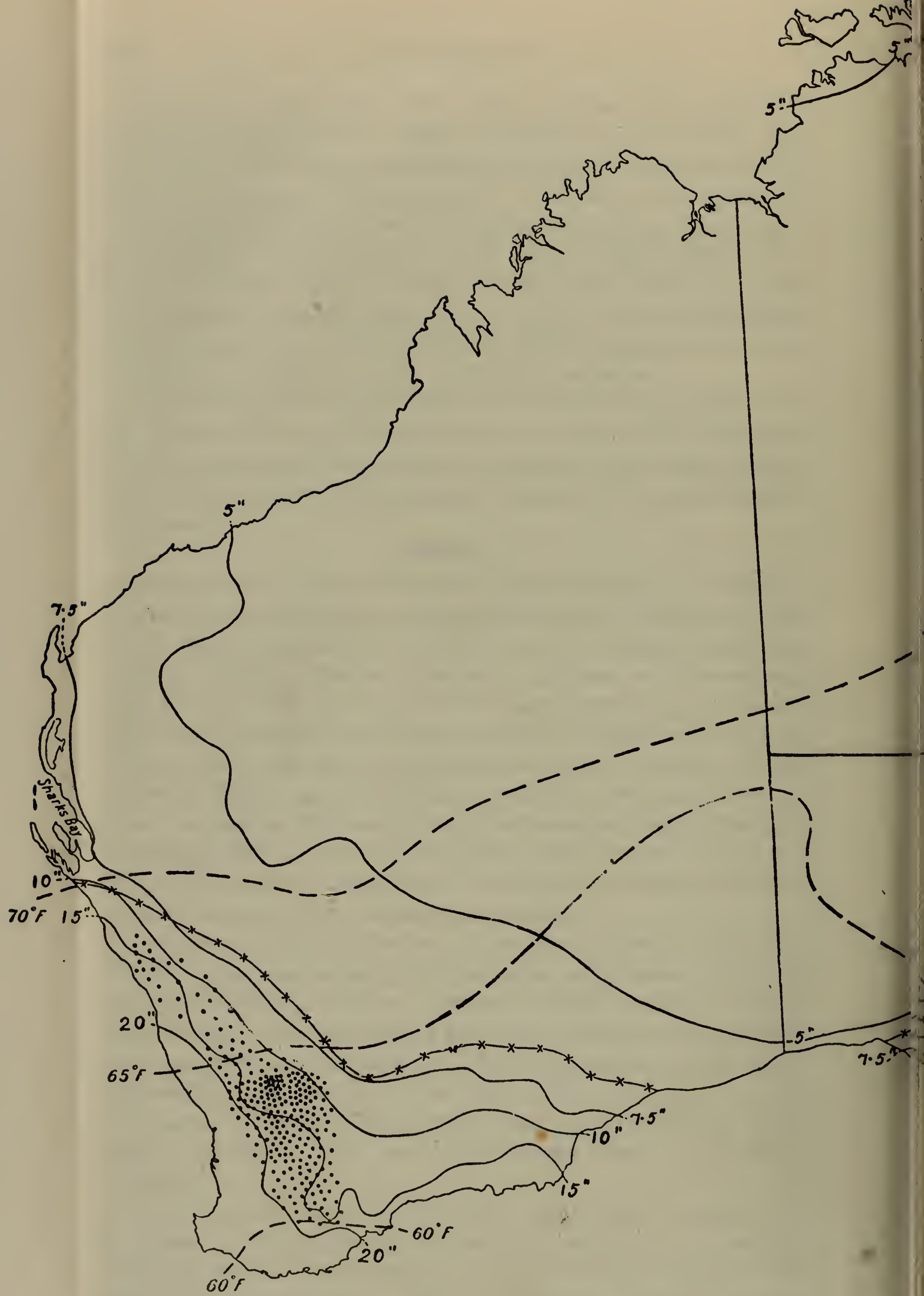
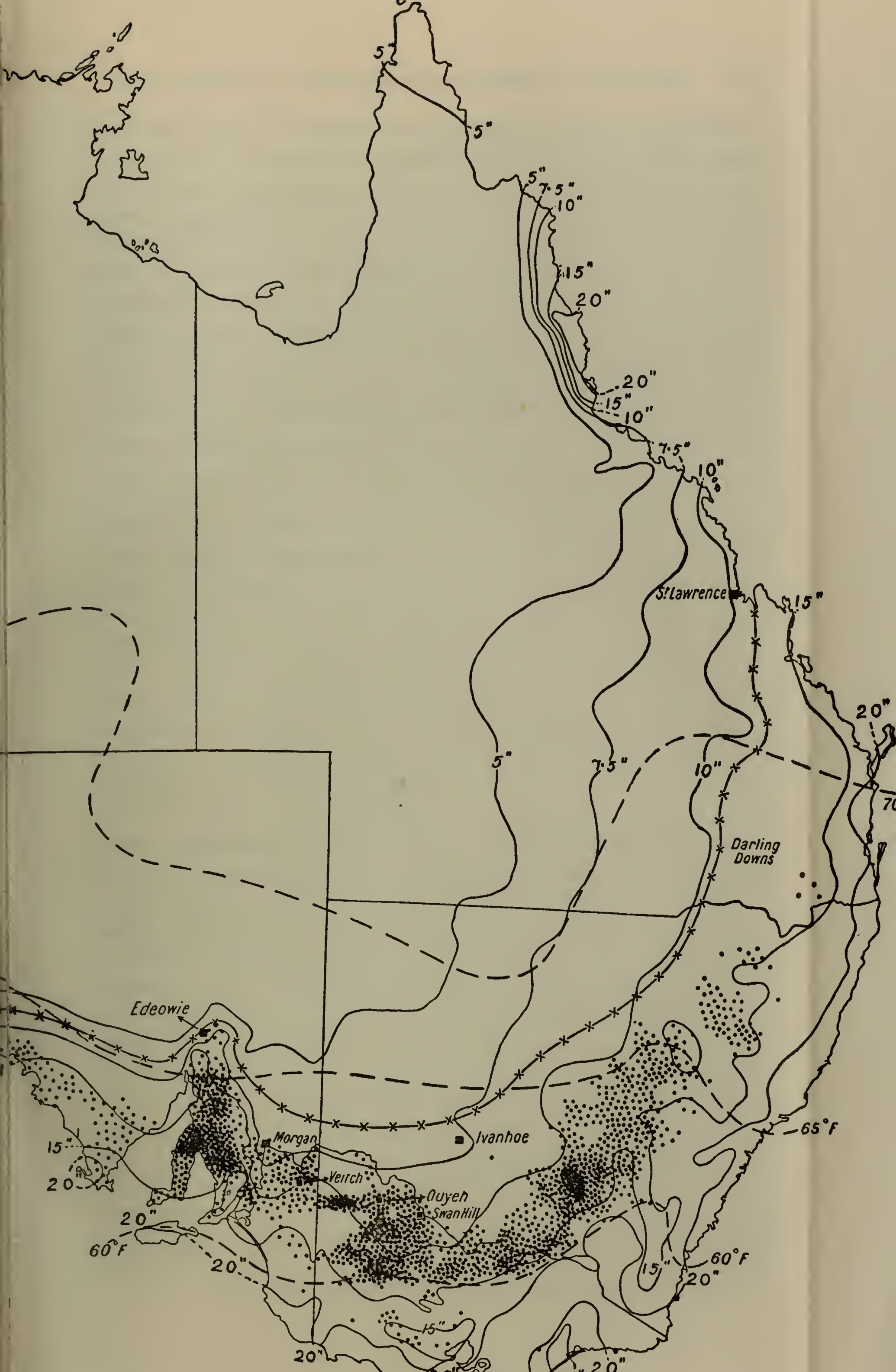


FIG 1.—DISTRIBUTION OF WHEAT ACREAGE IN AUSTRALI

Each dot represents 5,000 acres.
Lines of average "winter rainfall" shown thus ————————
Lines of average mean annual temperature shown thus — — — —
Lines showing probable inland limit of wheat belt as indicated by climatic conditions c
furthest inland areas under crop, shown thus ×–×–×



ale to the present

will vary widely in fertility, but it is safe to say that, within the regions to be indicated as suitable, and not yet used for wheat production, though there are areas of low soil fertility, there are many thousands of acres of which the soil is eminently suited to the growth of wheat. As regards the other two factors, rainfall and temperature, the rainfall both in its total amount and incidence in respect to the growing period of wheat, is far the more important. Temperature, in fact, can be almost disregarded as a limiting factor; there is no extensive area of cultivable land in Australia which is actually too cold for the growth of wheat, though in our colder districts other conditions combine to make it less profitable to grow wheat than other crops. Similarly, though wheat is not grown north of the 70 deg. isotherm, there is a considerable area north of this line climatically similar to the wheat-growing areas of India.[1] Here, again, it is the question of the degree of profitableness as compared with other agricultural and pastoral pursuits under our present conditions of development, rather than temperature, which limits the extension of the wheat area in a northerly direction. At the same time there is evidently an optium condition of temperature for wheat in Australia, for practically the whole of the area sown to wheat is situated between the 60 and 65 deg. F. isotherms, there being a marked coincidence between the 60 deg. isotherm and the southern limit of the wheat belt.

Considering the distribution of acreage in relation to the more important factor of rainfall, the rain of importance to wheat is that falling during the growing period of the crop, i.e., April-October, inclusive, the rain falling during the summer being largely lost by evaporation, and also sometimes tending to reduce the wheat yield by causing lodging of the crop and the spread of rust. Therefore the lines of rainfall shown are those for this period. It is seen that practically all our wheat is now grown between the lines of 7.5 and 15 inches of winter rainfall. In Western Australia there is certainly a considerable area between the 15 and 20 inch lines, but here settlement is so sparse that more intensive agriculture has not yet pushed the wheat belt back into its true sphere in the dry farming regions. In South Australia, Victoria and New South Wales, the 15-inch line corresponds very closely with the southern boundary of the wheat belt, this line approximately separating the dry farming

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[1]Vide Griffith Taylor, "The Australian Environment."

area from the closer settlement country where more intensive farming is possible. The 10-inch line of winter rainfall has usually been regarded as the safe limit for wheat growing, but in South Australia and Victoria wheat is grown over a very considerable area inside this line, extending to, and even passing the 7.5-inch line. The wheat-growing districts about Edeowie and Morgan in South Australia, and immediately south of Mildura in Victoria, are beyond the 7.5-inch line of winter rainfall; while between the 10 and 7.5-inch lines are the older settled Mallee districts of Veitch, Ouyen and Swan Hill, where wheat growing has been an established and successful industry for over 10 years. It can be fairly assumed then that country having a winter rainfall of somewhat under 7.5 inches, of reliability equal to that in the areas indicated, and an average temperature not greatly above that of these areas, is capable of growing wheat under our present methods of cultivation and economic conditions of price of wheat, land and labour. In New South Wales the 10-inch line has not yet been passed, and it would seem that in the northern portion of the State it does indicate the probable limit of the wheat belt. The greater variability of the rainfall, and the higher temperature, causing increased loss by evaporation, make a given average rainfall less efficient in crop production here than a similar amount in the cooler and more reliable rainfall areas in the southern portion of the State.

It is difficult, indeed, to indicate the ultimate inland limits of the wheat belt in Australia, for with improved, drought-resistant varieties, and better methods of cultivation, new areas are being brought under crop which but a few years previously it was thought impossible to successfully cultivate. This increasing efficiency will, it is hoped, continue. But even with our present knowledge there is ample room for expansion before what may be termed the probable limits of the wheat belt in the more immediate future are reached. The line shown thus: —x—x—, is an arbitrary line, indicating what appears, from climatic considerations, to be such probable limit, and it is seen to enclose immense tracts beyond the present limits of development. Commencing on the 10-inch winter rainfall line, south of Shark's Bay, W.A., where the variability of the rainfall, is too great to warrant an extension of the 7.5-inch line, it passes west beyond the 7.5 line, as the more reliable rainfall along the southern coast is reached. In this State alone we see a vast area of country awaiting exploitation, the greater portion of it having a winter rainfall equal in reliability and total amount to the well-developed wheat belt in Victoria. Along the west coast of South Australia this reliability of rainfall still holds, and here again might be expected a development beyond the 7.5-inch line, as has already occurred in the regions of less reliable rainfall about Edeowie. Passing over the extension of the belt north of Spencer's Gulf, the line turns southwards and runs somewhat north of the Murray, and approximately parallel to the 7.5-inch line to about Ivanhoe, N.S.W., enclosing the immense tract of fertile Riverina country. Thence the line passes north-east beyond the 10-inch line, and north to St. Lawrence on the Queensland coast. As previously stated, the greater variability and higher temperature make the actual rainfall less effective than in the southern areas; hence this marked departure from the 7.5-inch line. As to the probable northerly limits of the belt, although there is a considerable area shown with a sufficient winter rainfall, and where wheat can doubtless be grown, yet it seems unlikely that any considerable amount will be grown north of the Darling Downs, the high temperature, ample rainfall, and its summer incidence combining to make wheat less profitable than other crops.

The present wheat belt, as shown, extends over an area of some 124 million acres, of which only one acre in fifteen, or a total of nearly eight million acres was under wheat in 1918-19. Since none of this is mountainous country, and wheat is everywhere the principal crop, it might be expected that the area at present sown will be about trebled before this belt is utilised to anything like its full capacity. But, apart from this area, there is in the probable wheat belt indicated further inland an area of some 138 million acres. Assuming that this area can be developed only to the same extent as at present obtains in the Victorian Mallee, which is indeed a reasonable assumption when it is remembered that 20 years ago the advisability of abandoning the Mallee for settlement was seriously considered, and that even now but a relatively small portion of it is developed to any extent, this area would then carry a population of some 570,000, or 2½ people per square mile.

Aggregating the two areas, we have a wheat belt of over 260 million acres. Of this we might ultimately expect at least 40 million acres under crop each year; this, with an average yield of 10 bushels per acre, would give at least 400 million bushels annually, which, at the present Australian rate of consumption per head of population, and deducting the necessary quantity required for seed, would supply flour sufficient for the requirements of over 50 millions of people. It is not to be thought that even this is considered the limit of our possibilities as a wheat-producing country. It is a conservative estimate of the possible production from this area only, based on a low proportion of land under crop and a low average yield per acre. In the closer settlement country, wheat can be grown in rotation with other crops under conditions of intensive agriculture; the acreage sown in these areas would not approach that of the wheat belt, but with a higher average yield per acre the production would be appreciable.

It is clearly evident that the factors determining the present actual limits of the wheat belt are economic and not natural ones. The limits on the coastal side of the belt are determined by questions of profit in competition with other crop and live stock industries; inland, practically in all cases by transport facilities. The most striking instance of this is in the undeveloped areas of Mallee land on either side of the Ouyen-Murrayville railway line. Again, the decided boundary in South Australia and New South Wales where the wheat belt stops at the Murray River, coincident with the limits of railway facilities. We have a long way to go in extending this, the chief present economic limit to the development of the wheat industry, before we approach the natural boundaries indicated above.

Sheep.

In the year under consideration, the sheep population of Australia numbered some 85,194,503, and of these New South Wales claims 37,381,874, Queensland 18,220,985, Victoria 15,773,902, Western Australia 7,183,747, South Australia 6,625,184, and Northern Territory 8,811 head. This number represents approximately 16 per cent. of the world's sheep, emphasising Australia's position as a leading sheep and wool-producing country.

Examining the distribution of the sheep throughout the continent (Plate II.), it is seen that the belt of maximum concentration is in South-eastern Australia, and that it coincides roughly with the wheat belt, the main departure being in the

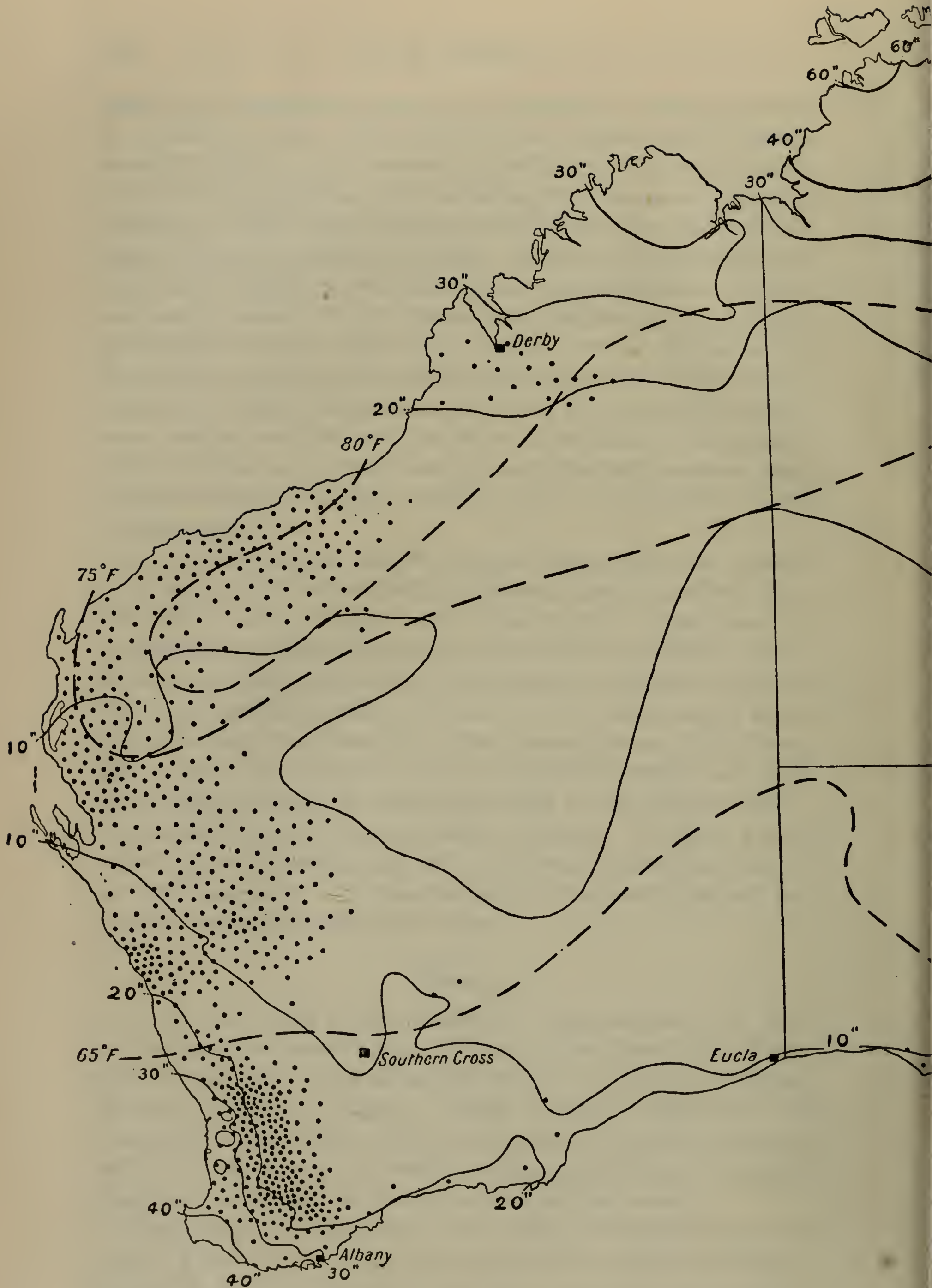


FIG. 2.—DISTRIBUTION OF SHEEP IN AUSTRALIA.

Each dot represents 10,000 sheep.
Lines of average annual rainfall shown thus ————
Lines of average mean annual temperature shown thus — —


60"
80°F
60"
40"
30"
60"
60"
75°F
30" 40"
20"
Cloncurry
60"
60"
60"
10"
40"
atta 5"
5"
60"
60"
60"
65°F
20" 20"
20"
40"
30"
30"
30"
30"
55°F
40" 40"
55°F

famous sheep country of the Western District of Victoria. The sheep-carrying country, however, extends much further inland and northwards than does the wheat belt. The area of maximum concentration commences in New South Wales, somewhat above the 65 deg. F. isotherm, and runs south-west through that State and Victoria on either side of the 20-inch line of annual rainfall. Such conditions of rainfall and temperature below 65 deg. F. are, given suitable soil, evidently the optimum conditions for sheep in Australia. From this region of maximum concentration there is a wide belt of decreasing sheep concentration extending inland beyond Oodnadatta, and including the South Australian sheep country. The most noticeable breaks in this passage from the maximum to the minimum concentration are: (1) the low concentration areas of the Victorian and South Australian Mallee, where grazing to any extent is only possible after the land has been cleared and cultivated; and (2) the area of higher concentration, where the rainfall isohyets run northwards of the Mt. Lofty Ranges. It is worthy of note that along the moister eastern side of the continent there are no appreciable numbers of sheep close to the coast line; not, in fact, until the belt of maximum cattle concentration is passed. The distribution of sheep is apparently limited here by the high rainfall, practically no sheep being found beyond the 40-inch line of rainfall. The liability to such troubles as foot-rot, liver-fluke, and other parasitic diseases is evidently one of the factors making the keeping of sheep in such districts less profitable than cattle-raising.

Appreciable numbers of sheep are found as far north as Cloncurry and beyond in Queensland, and around Derby in Western Australia, both being about latitude 18 deg. S.; while, however, in Queensland the sheep do not extend appreciably beyond the 75 deg. F. isotherm, in Western Australia, the isotherms dipping south, they appear considerably above the 80 deg. F. isotherm. The temperature range of sheep is therefore considerable, as in the south-eastern corner of the continent they are found in country having a mean annual temperature below 55 deg. F.

In Queensland the greatest concentration of sheep is about Longreach, where, it is to be noted, there is a relatively sparse distribution of cattle. Over the rest of the State, inside the high rainfall coastal belt, and south of the 75 deg. F. isotherm, the distribution is fairly uniform and comparatively dense. Western Australia has a small percentage of her total area as sheep-carrying country, and no region where the distribution can claim to be dense. The sheep belt is along the coast; here, however, except in the extreme south-western corner, a coastal region of low rainfall.

Considering the possible extension of the sheep-carrying areas. This extension, it may be noted, has not been very rapid over the last 20 years, the numbers of sheep in Australia in 1900 and 1918 being respectively: 70,602,995 and 85,194,503, or an increase of 20 per cent. as compared with an increase of 33 per cent in human population. There is no reason why the numbers should not be considerably increased, both by the better management of present pasture lands, and the opening up of new country. The areas suggesting themselves as potential sheep country are: (1) the Victorian and South Australian Mallee lands, where the stocking of the country does not, as is usual, precede, but follows on after, the clearing and cultivation of the land. At present few of the Mallee settlers keep sheep, but with the passing of the pioneering stages of settlement, the number of small flocks kept is gradually increasing. Better transport facilities, more than anything else, would greatly aid the development of this section. (2) There is a considerable stretch of country along the southern coast of Western Australia, bounded roughly by Southern Cross, Albany and Eucla, which is practically devoid of sheep population. This is all within the 10-inch line of rainfall, and from climatic considerations above it should have a carrying capacity at least equal to the South Australian west coast, and other 10-15-inch rainfall areas. Indeed, compared with South Australia, where there is the greatest development of the arid country, we might look for an extension still further inland than the area indicated. Even allowing for a considerable proportion of inferior soil, there seems every reason to believe that this area is capable of supporting a population of sheep, certainly sparse, but aggregating many thousands of head. (3) In Queensland, the limits of the present distribution show a fairly sharp line, both along the northern and western boundaries. Allowing that the high temperature and heavy rainfall combine to make a northern extension of the sheep belt unlikely, there remains between the Queensland western boundary of the present distribution and the sheep-carrying areas of the north-west coast an immense tract of country still to be exploited. The population in Queensland between the 10 and 20-inch lines of rainfall, and

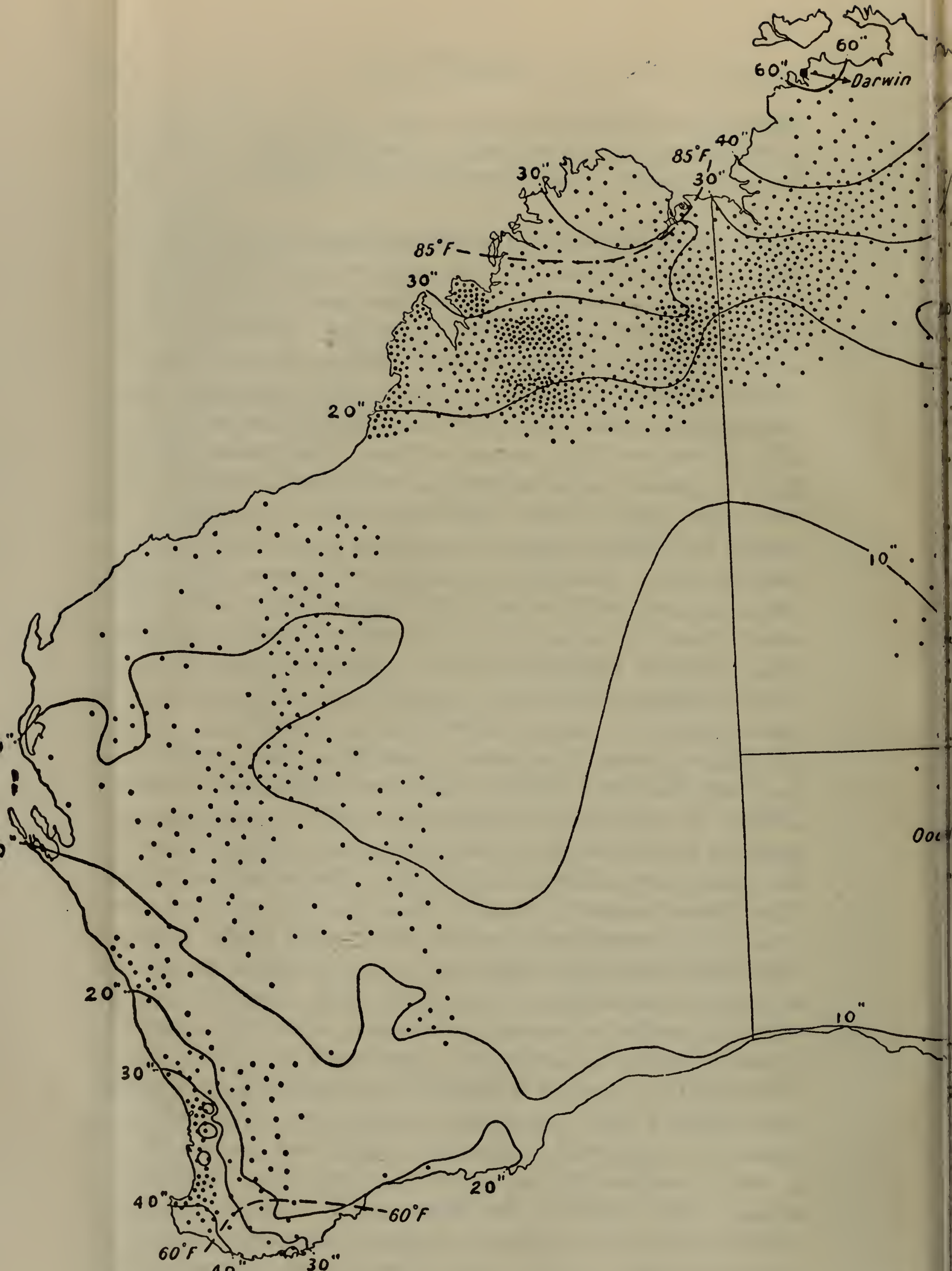
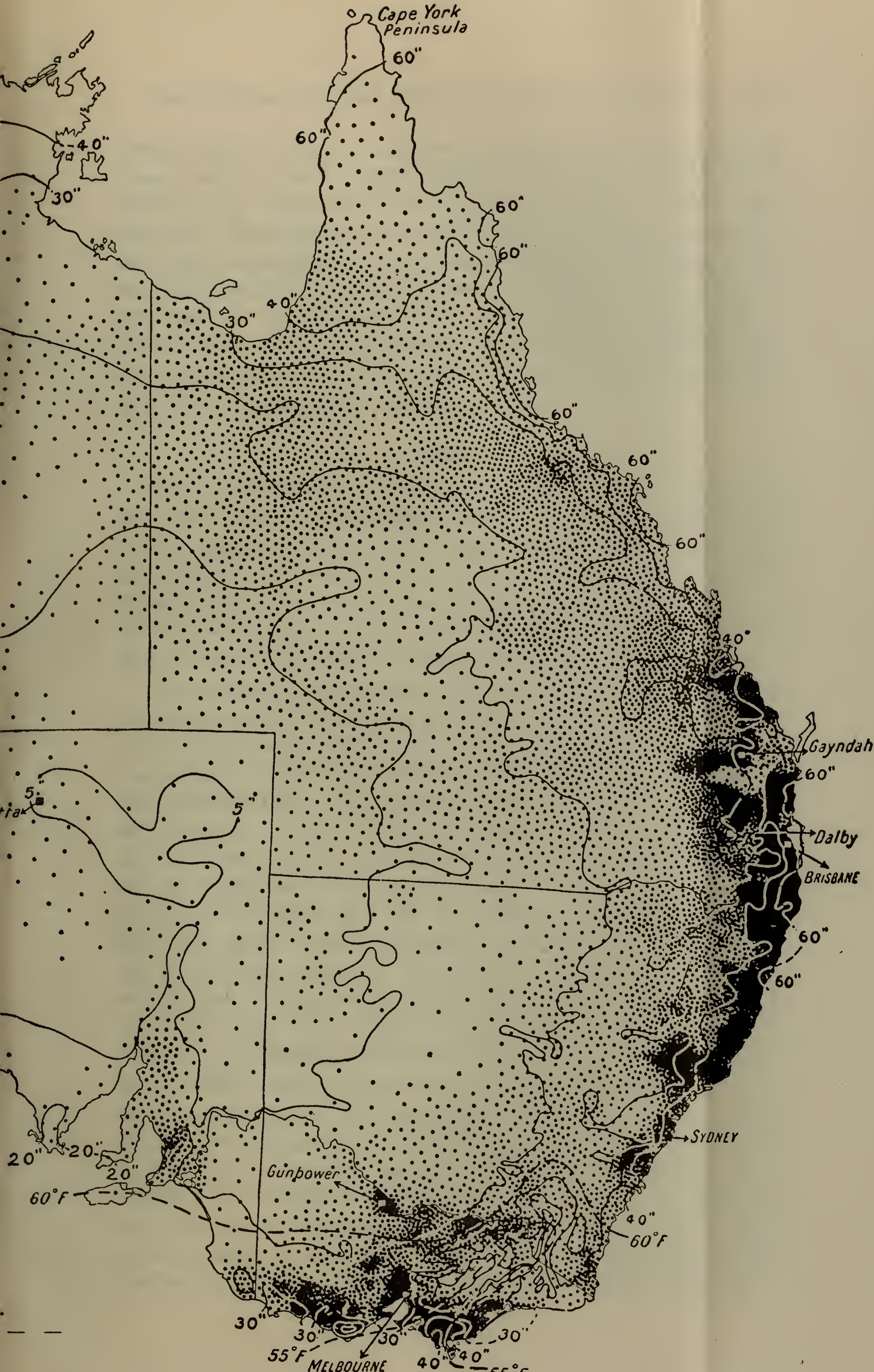


Fig. 3.—Distribution of Cattle in Australia.

Each dot represents 1,000 head.
Lines of average annual rainfall shown thus ———
Lines of average mean annual temperature shown thus — —



Cape York Peninsula
60"
30"
40"
5"
Gayndah
Dalby
BRISBANE
SYDNEY
Gunbower
MELBOURNE
20"
60°F
55°F

close to the 75 deg. F. isotherm, is seen to be comparatively dense, and it can be fairly assumed that such conditions of rainfall and temperature are quite favorable to the sheep industry. Between these lines of rainfall and approximating to the same temperature is a vast tract of country stretching across the Northern Territory and Western Australia. Large areas of this land are doubtless of a more or less barren nature, but it seems likely that, with increased population and improved communication and transport facilities, this area will contribute appreciably to Australia's sheep products.

Cattle.

There was in 1918-19 a total of 12,576,842 cattle in Australia, of which number Queensland possessed 5,786,744, New South Wales 3,280,676, Victoria 1,601,544, Western Australia 943,847, the Northern Territory 621,163, and South Australia 342,768. These figures show an increase of approximately 46 per cent. on the total of 8,640,225 for the year 1900, being a much more rapid increase than that shown by sheep over the same period.

Examining the map of cattle distribution (Plate III.), the most noticeable feature is the very general nature of such distribution, cattle being found under very diverse conditions of rainfall and temperature, right from Darwin and Cape York Peninsula to the southern coast. The rainfall range is from 5 inches in the arid interior to over 60 inches on coastal Queensland and New South Wales, and the temperature range from over 85 deg. F. in the far north-west to below 55 deg. F. in the south-eastern corner. The ability of cattle to withstand both cold and heat, and their great travelling capacity, making them invaluable in the pioneering stages of a country's development, are here emphasised. Compared with the distribution of sheep, they not only show this wider range, proving their greater adaptability to varying conditions, but also the regions of maximum concentration differ markedly from those of sheep. The areas of maximum concentration are found along the coasts of New South Wales and Queensland, commencing just outside the sheep country, and in districts having a rainfall of 40 inches and over. Under such conditions cattle-raising and dairying, as compared with sheep, are evidently so much more profitable as to practically totally exclude the latter. The next greatest concentration is found in Gippsland and the Western District of

Victoria, with temperate climate and rainfall of 30 inches and upwards, but in these areas sheep also are found.

The influence of the big capital cities in increasing the cattle population (for dairying and fattening purposes) is clearly shown in the comparatively poor country north of Melbourne, and to a lesser extent around Sydney and Brisbane. The irrigation of the drier areas has a like effect, as shown by the relatively dense population in the county of Gunbower, Victoria, where the annual rainfall is under 15 inches. The effect of varying soil fertility and topography is strikingly shown in Queensland, where between Dalby and Gayndah, within a relatively short distance, and under much the same conditions of temperature and rainfall (about the 30-inch line), we pass through a region of maximum concentration to one of very sparse distribution, and again through a maximum concentration area.

What may be called the inverse distribution of sheep and cattle holds throughout, for it will be seen that in Central Queensland and New South Wales, and in Western Australia, where cattle are relatively sparsely distributed, sheep are relatively dense, and vice versa.

As regards the possible extension of the present boundaries of cattle distribution, it is seen that the eastern half of the continent is practically totally inhabited, and development is here limited to the closer population of already inhabited areas. In the western portion, however, there are vast unoccupied areas, a large proportion of which show promise of in the future carrying a considerable number of cattle. Climatically, there seems no reason why the cattle population of Queensland inside the 20-inch line of rainfall should not extend across the similar belt through the Northern Territory and Western Australia. The regularity of the rainfall over most of this area is quite as great as in some of the well-populated country of Queensland, with a similar annual total. Artesian and sub-artesian water has helped greatly in the latter region, and there seems every prospect of this being obtainable over much of the country indicated. Then there is the south-western portion of the continent, having a rainfall of over 10 inches, and here of great regularity, to be regarded as the potential carrier of a sparse cattle population, with the possibility of a concentration in the extreme south-west corner where the rainfall is over 30 inches. Here there are now, relative to the rainfall, very few cattle, the country in its natural state being unsuited to grazing; but with the progress of agriculture there is every reason to expect a rapid increase in the numbers of cattle maintained in this well-watered region.

A word as to the agricultural potentialities of Australia as indicated by this cattle distribution map. It is an axiom among stockmen that "cattle country is good country"; and when we consider not only the great concentration along the fertile coastal belt of the continent, but also the vast areas of New South Wales, north-west Australia, and particularly Queensland, carrying relative to their human population and stage of development, a dense and uniform stock population (for it must be remembered that sheep largely fill up what appear to be the blanks in the cattle map), we can see room for a tremendous increase in Australia's population, her stock and agricultural industries, before there is need to seriously consider how we are to support her excess population in that arid interior of which we are frequently reminded. Even in this arid interior we find, along the only long-established line of communication, viz., the Oodnadatta railway line and telegraph line to Darwin, some cattle; and it seems evident that, as our knowledge of the country and facilities for communication and transport improve, much of this country will carry stock in numbers quite sufficient to repudiate the name of desert.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. II., 1922.]

Art. XV.—*Additions to and Alterations in the Catalogue of Victorian Marine Mollusca.*

By J. H. GATLIFF and C. J. GABRIEL.

[Read 10th November, 1921.]

Of recent years very many changes have been made in the nomenclature of the Mollusca, not only in the generic and specific names, but also in some instances a consequential alteration in the name of the family. But as these changes have been adopted, more or less, by the British Museum, the United States National Museum; in the several States of this Commonwealth; and New Zealand, we have set out those which are necessary.

In addition to the alterations, 43 more species have been added. These include six in the Class *Cephalopoda,* obtained by the ill-fated trawler *Endeavour,* and six in the *Polyplacophora.*

At our request the Molluscan material collected by Mr. Joseph Gabriel, in 1910, for the National Museum from the cable extending from the Victorian coast to Tasmania, which was then being raised, was submitted to us for examination at the end of last year. A list of the shells thus obtained was made out and is included in the following catalogue.

As indicated herein, it provides 13 additional species; that of the genus *Daphnobela,* sp.? being of special interest, as there is no record of its previous existence. The genotype was obtained in the Eocene at Muddy Creek, Victoria.

We have to acknowledge the kind assistance of Mr. C. Hedley, Sydney; Sir Joseph Verco, and Mr. E. Ashby, Adelaide; and Mr. W. L. May, of Tasmania.

In Vol. IV., Part 5, of the Biological Results of the Commonwealth trawler *Endeavour,* Professor S. S. Berry gives a full and excellent Report of the *Cephalopoda* obtained by that vessel, and from his work we are enabled to make the following additions to, and alterations in, the naming of our Mollusca.

Class CEPHALOPODA.

Order DIBRANCHIATA.

Suborder Decapoda.

Family ENOPLOTEUTHIDAE.

Genus **Enoploteuthis,** d'Orbigny 1844.

Enoploteuthis galaxias, Berry.

1918. *Enoploteuthis galaxis,* Berry. *loc. cit.* pp. 211-221, pl. 59-60.

Hab.—200-250 fathoms, Gabo Island, to region of Cape Everard, Victoria.

Family HISTIOTEUTHIDAE.

Genus **Calliteuthis,** Verrill 1880.

Calliteuthis miranda, Berry.

1918. *Calliteuthis miranda,* Berry. *loc. cit.* pp. 221-228, pl. 61-62.

Hab.—270 fathoms, S.E. x S. of Gabo Island, Victoria.

Family OMMASTREPHIDAE.

Genus **Nototodarus,** Pfeffer 1912.

Nototodarus gouldi, McCoy.

1897. *Ommatostrephes gouldi,* McCoy. Pritchard and Gatliff, these Proc., v. X., p. 243 .

1918. *Nototodarus gouldi,* McCoy. Berry. *loc. cit.* p. 228, pl. 63-66.

Hab.—60-220 fathoms, Bass Strait.

Family LOLIGINIDAE.

Genus **Loligo,** Schneider 1784.

Loligo etheridgei, Berry.

1918. *Loligo etheridgei,* Berry. *loc. cit.* pp. 243-249, pl. 67-68, pl. 69, f. 1, 2.

Hab.—S.E. Australia.

Family SEPIOLIDAE.

Genus **Rossia,** Owen 1834.

ROSSIA (AUSTROROSSIA) AUSTRALIS, Berry.

1918. *Rissoa* (*Austrorossia*) *australis,* Berry. *loc. cit.* pp. 252-258, pl. 69, f. 3, 4, and pl. 70.

Hab.—200-250 fathoms, Gabo Island to Everard grounds, Victoria.

Family CIRROTEUTHIDAE.

Genus **Opisthoteuthis,** Verrill 1883.

OPISTHOTEUTHIS PERSEPHONE, Berry.

1918. *Opisthoteuthis persephone,* Berry. *loc. cit.* pp. 290-293, pl. 81, f. 6, 7; pl. 82, f. 9, 10, and pl. 85-88.

Hab.—200 fathoms, 42 miles south and east of Genoa Bank, Victoria.

Suborder OCTOPODA.

Family POLYPODIDAE.

Genus **Polypus,** Schneider 1784.

POLYPUS VARIOLATUS, Blainville.

? 1821. *Sepia boscii,* Lesueur. Jour. Acad. Nat. Sci. Philad. v. II., p. 101 (nomen nudum).

? 1826. *Octopus variolatus,* Bl. Dict. Sci. Nat., v. XLIII., p. 186.

1897. *Octopus boscii,* Lesueur. Pritchard and Gatliff, these Proc., v. X., p. 241.

1918. *Polypus variolatus,* Bl. Berry. *loc. cit.* p. 278, pl. 79, 80, pl. 81, f. 2, 3, and pl. 82, f. 1-4.

Hab.—Eastern slopes of Bass Strait.

POLYPUS AUSTRALIS, Hoyle.

1897. *Octopus australis,* Hoyle. Prit. and Gat., these Proc., v. X., p. 241.

1918. *Polypus australis,* Hoyle. Berry. *loc. cit.* pp. 276-278, pl. 78, f. 1, 2, and pl. 81, f. 1.

Hab.—200 fathoms, off Gabo Island.

Genus **Murex,** Linne 1758.

MUREX PLANILIRATUS, Reeve.

1898. *Murex planiliratus,* Rve. Prit. and Gat., these Proc., v. X., p. 254.

1916. *Murex fimbriatus,* Lk., not of Solander, Iredale, P. Mal. Soc. Lond., v. XII., p. 93.

1917. *Murex fimbriatus,* Lk., Gatliff and Gabriel, these Proc., v. XXX., p. 21.

Genus **Typhis,** Montfort 1810.

TYPHIS PHILIPPENSIS, Watson.

Typhis cleryi, Sowb. not of Petit. Prit. and Gat., these Proc., v. X., p. 255.

Genus **Lepsiella,** Iredale 1912.

LEPSIELLA VINOSA, Lamarck.

1917. *Kalydon vinosus,* Lk., Gat. and Gab., these Proc., v. XXX., p. 22.

The following species are also transferred to this genus: *Sistrum reticulatum,* Quoy and G., and *Trophon flindersi,* Ad. and Ang.

Genus **Xymene,** Iredale 1915.

XYMENE PAIVAE, Crosse.

1898. *Trophon paivae,* Crosse. Prit. and Gat., these Proc., v. X., p. 257.

Genus **Neothais,** Iredale 1912.

This is another genus erected for Australasian forms, and will include those already listed as *Purpura succincta,* Martyn; and *P. baileyana,* Ten.-Woods.

Genus **Agnewia,** Tenison-Woods 1878.

AGNEWIA TRITONIFORMIS, Blainville.

1906. *Purpura tritoniformis,* Bl., Prit. and Gat., these Proc., v. XVIII., for 1905, p. 44.

Genus **Drupa,** Bolten 1798.

DRUPA ASPERA, Lamarck.

1898. *Sistrum asperum,* Lk., Prit. and Gat., these Proc., v. X., p. 261.

increases in surface moisture. The clearing of the land, and the substitution of cultivation or pastures for the scrub forests on the inland plains cause, according to the evidence, some improvement of the rainfall, especially during the spring months, when the green growth results in vigorous evaporation. A more general improvement results from irrigation, which ensures growth of vegetation throughout the year. It is through this means that the greatest effects are possible. The extension of irrigation along the Murray between Echuca and Renmark, and in New South Wales, about the junction of the Darling with the Murray, it is evident, will have a not inconsiderable effect in ameliorating the climate of Northern Victoria, including the Mallee. It should also increase the rainfall on the mountains from which the irrigation water are derived. And if in connection with these, large storages of water are made from the lower Murray and Darling, say, by impounding flood waters in banked-up lakes in the same way as those of the Goulburn are impounded in the Waranga basin, the possibilities, if not almost limitless, are at least very great. I see no reason why the improvement should not be equal to what would happen if an arm of the sea like Spencer's Gulf, say, up to Menindie. It has already been shown that a reasonable result of this would be an increased rainfall of from 3 to 5 inches in the neighbourhood, even as far as 170 miles inland.

If such a result could be brought about by increasing our irrigated areas, and the necessary increase in the area of land fully irrigated can surely be made, it would be hard to put any limit upon the climatic benefits which Northern Victoria and the Riverina would derive from it. Hann has shown that in New South Wales a square mile of country carries 22 more sheep per annum with a 12-inch than with an 11-inch rainfall, and that the carrying capacity increases at a more rapid rate per inch of rain as the rainfall increases, a 17-inch rainfall, for example, enabling 70 more sheep per square mile to be carried than a 16-inch one.

Such an increase in our irrigated areas is likely, therefore, not only to be worth while in its direct effects upon the country's production, but by making further irrigation possible, to have indirect effects of very appreciable magnitude.

[Proc. Roy. Soc. Victoria, 33 (N.S.), 1921]

Art. X.—*A Revision of the Genus Pultenaea, Part II.*

By H. B. WILLIAMSON.

(With Plates VI. and VII.)

[Read 9th September, 1920.]

Pultenaea humilis, Benth.

(Hook, f. Fl., Tasm., i., 91).

A shrub with flowers like those of *P. plumosa,* from which species it differs in having bracteoles with broad stipules, and flowers axillary in short leafy spikes at or near the ends of the branches, not in terminal heads. The common Victorian form is low and diffuse, with large flowers, the calyx lobes being much longer than the tube, lower ones much narrower than the upper, all hirsute with long hairs. Bracteoles are linear-lanceolate, ciliate, as long as the calyx lobes, and fixed at the base of the tube. The ovary is glabrous, with a brush of long white hairs at the top, and the style is much dilated. Grampians, Geelong, Ballarat, etc., Vic.

It appears to be confined to the southern half of Victoria.

P. humilis, var. glabrescens, var. nova.

Variat foliis fere glabris, floribus paulo minoribus saepe glabris.

From the normal this differs in having almost glabrous leaves, and somewhat smaller flowers often quite glabrous. Specimens from Grampians and Creswick, with narrow leaves have fallen wrongly under var. *angustifolia* of *P. parviflora,* Sieber, p. 132, Fl., Aust. The Grampians specimens are scantily invested with long hairs on the calyx and bracteoles, while those from Creswick have hairs only on the branchlets and pedicels. Goulburn River specimens (W. F. Gates), have larger, glabrous leaves and hairy branchlets and pedicels. Those from Sale, Vic., (T. A. Robinson), and Bairnsdale (T. S. Hart), have shorter leaves, broader towards the summit, and smaller flowers. All the specimens

This is the species already listed in these Proceedings as *Nassa glans,* of which it was considered to be a variety. Under this genus will also be included all of our species hitherto listed as *Nassa.*

Genus **Pterospira,** Harris 1897.

PTEROSPIRA ROADKNIGHTAE, McCoy.

1898. *Voluta roadknightae,* McCoy. Prit. and Gat., these Proc., v. X., p. 282.

We have examined the type of *Voluta hannafordi,* McCoy, a fossil the genotype of *Pterospira,* Harris, and consider it to be a progenitor of *V. roadknightae.* We asked the opinion of Mr. F. Chapman, Palaeontologist of the National Museum, Melbourne, as to whether he agreed with our generic classification; he decidedly coincided with us.

Genus **Livonia,** Gray 1855.

LIVONIA MAMILLA, Gray.

1908. *Voluta mamilla,* Gray. Gat. and Gab., these Proc. v. XXI., p. 371.

1909. *Voluta mamilla,* Gray. Gat. and Gab., Vic. Nat., v. XXVI., p. 117, pl. 2, 3.

Genus **Scaphella,** Swainson 1840.

SCAPHELLA MAGNIFICA, Lamarck.

1804. *Voluta magnifica,* Lamarck (Ch.) Ann. du Mus. Hist. Nat., vol. V., p. 156.

1840. *Scaphella magnifica,* Swainson. Treatise Malac., pp. 103-115, 118 and 120.

1914. *Voluta magnifica,* Chemnitz (not binomial). Gat. and Gab., these Proc., v. XXVII., p. 99.

Genus **Amoria,** Gray 1855.

AMORIA UNDULATA, Lamarck.

1898. *Voluta undulata,* Lk. Prit. and Gat., these Proc. v. X., p. 280.

AMORIA ZEBRA, Leach.

1898. *Voluta zebra,* Leach. Prit. and Gat., these Proc. v. X., p, 282.

Genus **Ericusa,** H. and A. Adam 1858.

Ericusa sowerbyi, Kiener.

1839. *Voluta sowerbyi,* Kr. Coq. Viv., p. 47, pl. 50.
1898. *Voluta fusiformis,* Swainson. Prit. and Gat., these Proc., v. X., p. 283.

Ericusa papillosa, Swainson.

1898. *Voluta papillosa,* Sw. Prit. and Gat., these Proc. v. X., p. 282.

Genus **Mitra,** Martyn, 1784.

Mitra analogica, Reeve, var. vincta, A. Adams.

1854. *Volutomitra vincta,* A. Ad. P.Z.S., Lond., p. 134.
1874. *Mitra vincta,* A. Ad. Sowb. Thes. Con., v. IV., p. 25, pl. 23, f. 520, 521.
1876. *Mitra teresiae,* Ten.-Wds. P.R.S., Tas., p. 140.
1901. *Turris vincta,* A.Ad. Tate and May, P.L.S., N.S.W., v. XXVI., p. 361.

Hab.—Coast generally.

Obs.—Our identification was confirmed on comparison with specimens in the British Museum. This variety and the following species are closely allied, but *M. vincta* may be distinguished by the absence of the longitudinal ribs on the later whorls.

Mitra tatei, Angas.

1878. *Mitra tatei,* Ang. P.Z.S., Lond., p. 861, pl. 54, f. 8.
1879. *Mitra weldii,* Ten.-Woods. P.R.S., Tas. for 1877, p. 93.
1899. *Turricula tasmanica,* Ten.-Wds. Prit. and Gat., these Proc., v. XI., for 1898, p. 188.
1902. *Mitra tasmanica,* Ten.-Wds. var. May. P.R.S. Tas., p.109, f. 2.

Hab.—Coast generally.

Obs.—We have been kindly favoured by the Tasmanian Museum with the loan, for examination, of the card on which are four shells, in the form of a square; the upper one on the right is what has been decided upon as the type of *Mitra tasmanica,* the upper one on the left is the shell Tenison-Woods alludes to as variety *a.* This is a very distinct species, and is figured by May, *loc. cit.*, and is the same as that listed by Prit. and Gat. as *M. tasmanica,* T.-Wds. Similar specimens have been sent to us from South Australia as *M. rufocincta,* A. Ad., but that species is described as impressed with transverse lines between the ribs, a character lacking in the shells sent, as also in *M. tatei.* Tenison-Woods *loc. cit.* says his species is " Small banded orange and dark brown; translucent with faint ribs on upper whorls. Long. 10, lat. 4 mm. Rather common. Long Bay and Blackman's Bay, and S.E.A." Upon examination of a very numerous series we find considerable variation, and that the ribs usually extend to the upper portion of the body-whorl, also that the colour is often blackish-brown bands on a white ground.

Under the genus *Mitra* will also be placed the shells listed as *Turricula scalariformis,* Ten.-Woods; and *Turris cinnamomea,* A. Adams.

Genus **Marginella,** Lamarck 1799.

MARGINELLA MUSTELINA, Angas.

1871. *Hyalina* (*Volvarina*) *mustelina,* Ang. P.Z.S., Lond., p. 14, pl. 1, f. 5.

1877. *Marginella stanislas,* Ten.-Wds. P.R.S. Tas. for 1876, p. 133.

1899. *Marginella albida,* Tate. Prit. and Gat., these Proc., v. XI., for 1898, p. 192.

1910. *Marginella stanislas,* Ten.-Wds. Gat. and Gab. *Id.* v. XXIII., p. 88.

Angas described the species as brown banded. Ten.-Woods states of *M. stanislas*: " Pellucid white, or marked with four zones of variously interrupted brown spots." Tate's species, *M. albida,* is white. The white variety may therefore be called *M. mustelina,* Ang. var. *stanislas,* Ten.-Woods, and Tate's name *M. albida* becomes a synonym.

MARGINELLA CRATERICULA, Tate and May.

1900. *Marginella cratericula,* Tate and May. J.R.S.S.A., v. XXIV., p. 91.

1901. *Marginella cratericula,* J. and M. P.L.S. N.S.W., v. XXVI., p. 363, pl. 26, f. 74.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Length 2.3, breadth 1.5 mm.

MARGINELLA COLUMNARIA, Hedley and May.

Marginella columnaria, Hed. and May. Rec. Austr. Mus., p. 120, pl. 23, f. 19.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Length 7.5, breadth 3.5 mm. Shell white, sub-cylindrical, triplicate.

MARGINELLA PULCHELLA, Kiener.

1830. *Marginella pulchella,* Kr. Coq. Viv., p. 27, pl. 9, f. 41 (not 40, as in text).

1911. *Marginella fulgurata,* Hed. Zool. Commonwealth trawler *Endeavour,* v. I., p. 110, pl. 7, fig. 31 only.

Hab.—Portland.

Obs.—This species has many axial undulating lines; these are thickened centrally, and near to each end, giving the appearance of encircling bands.

We also have the species from N.S. Wales, South Austr., and West Austr., and it has been sent to us from those States with the name of *M. sagittata,* Hinds, which species it resembles; we have the latter from Bahama Isls.

MARGINELLA GEMINATA, Hedley.

1903. *Marginella laevigata,* Hed., not of Braz. Mem. Aust. Mus., v. IV., p. 364, f. 89.

1912. *Marginella geminata,* Hed. Rec. Aust. Mus., v. VIII., p. 145, pl. 42, f. 28.

Hab.—Dredged in 7-8 fathoms, Western Port.

Obs.—Mr. Hedley states he mistakenly figured another shell as being *M. laevigata,* and later he described it as *M. geminata.* The earlier figure represents the shell we find, the later figure is probably drawn from an immature specimen. Mr. Hedley kindly sent us for examination and return co-types of the two species; they are very similar.

Family PYRENIDAE, replaces Columbellidae.

This change is necessary owing to *Pyrene,* Bolten 1798, being prior to *Columbella,* Lamarck 1799. *Pyrene* being a montypical genus represented by *P. rhombiferum,* Bolt., a new name he gave to *Buccinum punctatum,* Bruguiere 1789, and to the figure of which species he referred, we only adopt his generic name as applicable to similar forms. *Columbella mercatoria* being recognised as the type of Lamarck's genus, there being no forms similar to these two in our waters, and as it has been decided to split up the great assemblage of species hitherto classed as *Columbellidae,* we have adopted the following generic names for our species.

Genus **Mitrella,** Risso 1826.

Mitrella saccharata, Reeve.

1859. *Columbella saccharata,* Rve. Conch. Icon., pl. 29, f. 187.

1901. *Columbella* (*Mitrella*) *saccharata,* Rve. Tate and May, P.L.S., N.S.W., v. XXVI., p. 366.

Hab.—Dredged Western Port; taken off cable to Tasmania, Bass Strait.

Obs.—Its nearest congener is *C. semiconvexa,* Lk., from which it may be distinguished by its narrower form and smaller size; the type is in the British Museum; locality, "Van Diemen's Land."

Others listed as *Columbella* now included in *Mitrella* are *C. semiconvexa,* Lk.; *C. austrina,* Gask.; *C. menkeana,* Rve.; *C. lincolnensis,* Rve.; *C. angasi,* Braz.; *C. tenisoni,* Tryon; *C. tenuis,* Gask.; *C. tenebrica,* Rve.; *C. nubeculata,* Rve.; *C. beddomei,* Petterd; *C. legrandi,* Ten.-Wds.; *C. lurida,* Hed.; and *C. franklinensis,* Gat. and Gab.

Genus **Aesopus,** Gould 1860.

Aesopus cassandra, Hedley.

1909. *Daphnella cassandra,* Hed. Gat. and Gab., these Proc., v. XXIX., p. 37.

1918. *Aesopus cassandra,* Hed. Jour. R.S., N.S.W., v. LI. for 1917, p. 90, No. 948a.

Aesopus pallidulus, Hedley.

1907. *Mitromorpha pallidula,* Hed. Gat., these Proc., v. XX., p. 32.

1918. *Aesopus pallidulus,* Hed. *Id.* No. 948b.

We follow Mr. Hedley in his transference to this genus of the two foregoing species. And also transfer to it *Columbella plurisulcata,* Rve., previously listed by us.

The species listed as *Mangilia gatliffi,* Verco, will also be included in the genus *Aesopus.*

Genus **Zafra,** A. Adams 1860.

This contains the small axially plicate species, which we have already listed as *Columbella atkinsoni,* Ten.-Wds.; *C. smithi,* Ang.; *C. cominellaeformis,* Tate; and *C. remoensis,* Gat. and Gab. The last-named species is not a typical form, but at present we place it in this genus.

Genus **Retizafra,** Hedley 1918.

RETIZAFRA CALVA, Verco.

1911. *Columbella cclva,* Verco. Gat. and Gab., these Proc., v. XXIV., p. 194.

1913. *Retizafra calva,* Verco. Hed., P.L.S., N.S.W., v. XXXVIII., p. 326.

This genus comprises small forms with clathrate sculpture, and includes *Columbella gemmulifera,* Hed., already listed.

Genus **Conorbis,** Swainson 1840.

CONORBIS SARCINULA, Hedley.

1905. *Bathytoma sarcinula,* Hed. Rec. Austr. Mus., v. VI., p. 53, f. 21.

1918. *Apaturris sarcinula,* Hed. Jour. R.S., N.S.W., v. LI., for 1917, p. 80, No. 831.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Length 7, breadth 4 mm.

Mr. Hedley's excellent description and figure of the species, readily enabled the identification of our shell; his single specimen was dredged in 111 fathoms 12½ miles due east of Cape Byron. Mr. Hedley and one of us compared the single specimen got off the cable with the type; they were absolutely the same in size, colour and sculpture, and both fresh shells. We do not agree in the classing of it in either of the genera named, and place it in the genus *Conorbis.*

Family TURRIDAE, replaces Pleurotomidae.

Genus **Hemipleurotoma,** Cossmann 1889.

This includes the shell listed as *Drillia quoyi,* Desmoulins.

Genus **Glyphostoma**, Gabb 1872.

GLYPHOSTOMA WALCOTAE, Sowerby.

1893. *Drillia walcotae*, Sowb. P.Z.S., Lond., p. 487, pl. 38, f. 7-8.

1909. *Clathurella walcotae*, Sowb. Verco, T.R.S., S.A., v. XXXIII., p. 307.

Hab.—Portland.

Obs.—This is the largest of the species of this genus found in our waters, and may be recognised by its broad and robust form. The size of our shell is: Length 15, breadth 8 mm.

GLYPHOSTOMA NASSOIDES, Reeve.

1845. *Pleurotoma nassoides*, Rve. Conch. Icon., v. I., pl. 29, f. 259.

1884. *Clathurella nassoides*, Rve. Tryon, Man. Conch., v. VI., p. 296, pl. 15, f. 29.

1900. *Clathurella zonulata*, Ang. Prit. and Gat., these Proc., v. XII., p. 178.

Under the genus *Glyphostoma* will also be included the species listed as *Clathurella bicolor*, Ang.; *C. denseplicata*, Dkr.; and *C. kymatoessa*, Watson.

Genus **Macteola**, Hedley 1918.

This includes the species listed as *Mangilia anomala*, Ang., and it is selected by Hedley as his genotype.

Genus **Daphnella**, Hinds 1844.

DAPHNELLA CREBRIPLICATA, Reeve.

1846. *Pleurotoma crebriplicata*, Rve., P.Z.S., Lond., p. 3.

1846. *Pleurotoma crebriplicata*, Rve. Conch. Icon. v. I., pl. 34, f. 313.

1906. *Daphnella fragilis*, Rve. Prit. and Gat., these Proc., v. XVIII., p. 51.

Genus **Syntagma**, Iredale 1918.

This includes the species listed as *Donovania fenestrata*, Tate and May.

Genus **Exomilus**, Hedley 1913.

This includes the species listed as *Drillia telescopialis*, Verco; and *Mangilia hilum*, Hed.

Genus **Mitromorpha,** A. Adams 1865.

MITROMORPHA INCERTA, Pritchard and Gatliff.

1906. *Mangilia* (?) *incerta,* Prit. and Gat., these Proc., v. XVIII., p. 50.

Genus **Nepotilla,** Hedley 1918.

This includes the species listed as *Daphnella excavata,* Gatliff; and *D. microscopica,* May.

Genus **Taranis,** Jeffreys 1870.

This includes the species listed as *Daphnella lamellosa,* Sowb.; *D. triseriata,* Verco; and *D. mayi, Verco.*

Genus **Pseudodaphnella,** Boettger 1895.

This includes the species listed as *Clathurella tincta,* Rve.; *C. modesta,* Ang.; *C. sexdentata,* Prit. and Gat.; *C. albocincta,* Ang.; *C. legrandi,* Bedd.; and *Daphnella bitorquata,* Sowb.

Genus **Daphnobela,** Cossmann 1896.

DAPHNOBELA sp.?

A single specimen was obtained off the cable to Tasmania, Bass Strait; it has not yet been described or figured.

Genus **Cypraea,** Linnaeus 1758.

CYPRAEA ALBA, Cox.

1879. *Cypraea umbilicata,* Sowb. var. alba, Cox. P.L.S., N.S.W., v. IV., p. 386.

1885. *Cypraea umbilicata,* Sowb. var. alba, Cox. Tryon, Man. Conch., v. VII., p. 181.

1888. *Cypraea umbilicata,* Sowb. var. alba, Cox. Melvill, Proc. Manchester, Lit. and Phil. Soc., p. 58.

1907. *Cypraea umbilicata,* Sowb. var. alba, Cox. Hidalgo, Monog. Viv. Cypraea, pp. 548 and 579.

Hab.—Bass Strait.

CYPRAEA ALBA, Cox, var. HESITATA, Iredale.

1900. *Cypraea umbilicata,* Sowb. Prit. and Gat., these Proc., v. XII., for 1899, p. 187.

1912. *Cypraea umbilicata,* Sowb. Verco, T.R.S., S.A., v. XXXVI., p. 211.

1916. *Cypraea hesitata,* Ire. P. Mal. Soc. Lond., v. XII., p. 93.

1918. *Cypraea armenaiaca,* Hed., not of Verco. J.R.S., N.S.W., v. LI., for 1917, p. 70, No. 709.

Mr. Iredale *loc. cit.* proves that the name of *C. umbilicata* is pre-occupied by Dillwyn. As a new name had to be found for *C. umbilicata,* Sowb., the varietal name alba, Cox, P.L.S., N.S.W., vol. IV., 1879, is entitled to become the species name, and that of *C. hesitata* may be substituted as a varietal name.

Sir Joseph Verco *loc. cit.* fully gave the history of this species, and also named, what he thought might be a variety only, a shell with apricot colouration, as *Cypraea umbilicata,* Sowb., var. *armeniaca.* The description is full, and the figure excellent. Upon comparison with Tasmanian forms of *C. umbilicata,* Sowb. he remarks: "Mine differs in shape, being more globular, higher, and wider, not only relatively, but absolutely. . . . We will hope other specimens may be secured which will determine its right to be called a good species."

Of the specimens we have seen, including those in the Australian Museum, Sydney, none could be regarded as intergrading with *C. umbilicata,* Sowb., of which we have specimens from Tasmania, also dredged off Cape Everard (living), and Lakes Entrance, Victoria, and we have seen many others.

We therefore establish *Cypraea armeniaca,* Verco, as a species.

Genus **Natica,** Scopoli 1777.

NATICA SCHOUTANICA, May.

1912. *Natica schoutanica,* May. P.R.S., Tas., p. 45, pl. 2, f. 3.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: "Diameter, major 5.5, minor 4.5, height 5 mm." "Yellowish white, irregularly netted with broken zigzag lines of chestnut."

Genus **Polinices,** Montfort 1810.

This comprises species listed as *Natica plumbea,* Lk.; *N. didyma,* Ch.; *N. conica,* Lk.; *N. incei,* Phil.; and *N. beddomei,* Johnston.

Genus **Sinum,** Bolten 1798, replaces *Sigaretus,* Lamarck 1799.

Genus **Marseniopsis,** Bergh, replaces *Lamellaria,* Montagu.

Genus **Merria,** Gray, 1839, replaces *Vanikoro,* Quoy and Gaimard.

Genus **Siliquaria,** Bruguiere 1789, replaces *Tenagodes,* Guettard.

Genus **Architectonica,** Bolten 1798, replaces *Solarium,* Lamarck 1799.

Genus **Naricava,** Hedley 1913.

The species of *Adeorbis* we have listed have been transferred to the above genus; they are *A. vincentiana,* Ang.; *A. angasi, A. Adams;* and *A. kimberi,* Verco.

Genus **Epitonium,** Bolten 1798, replaces *Scala,* Klein 1753 (pre Linn.).

EPITONIUM ACULEATUM, Sowerby.

1844. *Scalaria aculeata,* Sowb. Thes. Conch., v. I., p. 86, pl. 32 bis, f. 35, 36.

1901. *Scalaria aculeata,* Sowb. Tate and May, P.L.S., N.S.W., v. XXVI., p. 379.

1906. *Scala aculeata,* Sowb. Verco, T.R.S., S.A., v. XXX., p. 143.

Hab.—Dredged in 6-8 fathoms, living, off Phillip Isl., Western Port.

We have dredged specimens 32 mm. in length by 11 mm. in breadth.

This genus will also include *S. jukesiana,* Forbes; *S. australis,* Lk.; *S. granosa,* Q. and G.; *S. tenella,* Hutt.; *S. morchi,* Ang.; *S. acanthopleura,* Verco; and *S. platypleura,* Verco.

Genus **Phalium,** Rostock 1807.

PHALIUM SINUOSUM, Verco.

1904. *Cassidea sinuosa,* Verco. T.R.S., S.A., v. XXVIII., p. 141, pl. 26, f. 7-10.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Length 24, breadth 15 mm.; differs from its nearest relative *C. adcocki,* in not having nodules on the last whorl, and the labrum is not thickened, but sinuous.

Under the genus *Phalium* are included the shells listed as *Cassis pyrum,* Lk.; *C. achatina,* Lk.; *C. semigranosa,* Lk.; *C. adcocki, Sowb.;* and *C. achatina,* Lk., var. *stadialis,* Hed.

Family STROMBIFORMIDAE, replaces Eulimidae.

Genus **Melanella**, Bowditch 1822, replaces *Eulima*, Risso 1826.

This includes species already listed as *Eulima indiscreta*, Tate; *E. commensalis*, Tate; *E. augur*, Ang.; *E. inflata*, Tate and May; *E. tryoni*, Tate and May; *E. immaculata*, Prit. and Gat.; *E. tenisoni*, Tryon; *E. orthopleura*, Tate; and *E. victoriae*, Gat. and Gab.

Genus **Mucronalia**, A. Adams 1862.

This includes our species listed as *Eulima mucronata*, Sowb., and *E. coxi*, Pilsbry.

Genus **Strombiformis**, Da Costa 1778.

This includes our species listed as *Leiostraca acutissima*, Sowb.; *L. lodderae*, Hed.; *L. kilcundae*, Gat. and Gab.; *L. styliformis*, Gat. and Gab.; *L. joshuana*, Gat. and Gab.; *Rissoa perexigua*, Tate and May; *Eulima topaziaca*, Hed.; and *E. marginata*, Ten.-Woods.

Genus **Syrnola**, A. Adams 1860.

This includes our species listed as *Pyramidella bifasciata*, Ten.-Wds.; *P. tincta*, Ang.; and *P. jonesiana*, Tate.

Genus **Leucotina**, A. Adams 1860.

This includes our species listed as *Turbonilla* (*Ondina*) *micra*, Prit. and Gat.; *T.* (*Ondina*) *casta*, A. Ad.; and *T.* (*Ondina*) *harrissoni*, Tate and May.

Genus **Cingulina**, A. Adams 1860.

CINGULINA SPINA, Crosse and Fischer.

Now classed as *Cingulina*, instead of *Turbonilla spina*, as formerly listed.

Genus **Oscilla**, A. Adams 1867.

OSCILLA TASMANICA, Tenison-Woods.

1906. *Oscilla ligata*, Ang. Prit. and Gat., these Proc., v. XVIII., for 1905, p. 59.

Both these names were published in the same year; it has now been ascertained that T.-Wds. has priority. Angas was the first to figure it. *O. ligata*, Ang., becomes a synonym.

Genus **Cerithiopsis,** Forbes and Hanley 1853.

CERITHIOPSIS CESSICUS, Hedley.

1906. *Bittium minimum,* Ten.-Woods. Prit. and Gat., these Proc., v. XVIII., for 1905, p. 59, not of Brusina, 1864.

1906. *Cerithiopsis cessicus,* Hed. P.L.S., N.S.W, v. XXX., p. 529.

Genus **Batillaria,** Benson 1842.

This includes our shell listed as *Potamides australis,* Quoy and Gaim.

Genus **Diala,** A. Adams 1861.

DIALA SEMISTRIATA, Philippi.

The shell previously listed as *Diala varia,* A. Adams, becomes a synonym, as it had already been named as above (fide Melvill and Standen, also Suter).

Genus **Melarhaphe,** Menke 1828.

MELARHAPHE UNIFASCIATA, Gray.

1827. *Littorina unifasciata,* Gray. King's Survey of Australia, v. II., App. p. 483.

1902. *Littorina mauritiana,* Lk. Prit. and Gat., these Proc., v. XIV., for 1901, p. 90.

Our shell is very similar to *mauritiana,* Lk., and the brief original description of it, as far as it goes, covers both species, but the clear and ample description by Gray enables their separation; *unifasciata* is found all round the coast of Australia; Tasmania; also in New Zealand.

Included in the genus is the species listed as *Littorina novae zealandiae,* Rve.

Genus **Liotia,** Gray 1842. (*Pseudoliotia,* Tate 1898 is a synonym.)

Our shell listed as *Pseudoliotia micans,* A. Ad., is now called a *Liotia.*

Genus **Liotina,** Fischer 1885.

The shells previously listed as *Liotia australis,* Kr.; *L. subquadrata,* Ten.-Woods; *L. tasmanica,* Ten.-Wds.; *L. hedleyi,* Prit. and Gat.; and *L. mayana,* Tate, are now classed as *Liotina.*

Genus **Liotella,** Iredale 1915.

In this genus are included *Liotia annulata,* Ten.-Woods, and *Liotia petalifera,* Hed. and May.

Genus **Cyclostrema,** Marryat 1818.

This genus has been greatly split up, and some new genera erected. We class ours already listed as follow:—

Genus **Elachorbis,** Iredale 1915.

This includes the shells already listed as *Cyclostrema caperatum,* Tate; *C. delectabile,* Tate; *C. inscriptum,* Tate; *C. harriettae,* Petterd; and *C. homalon,* Verco.

Genus **Brookula,** Iredale 1912.

This includes the shells listed as *Cyclostrema angeli,* Ten.-Wds.; *C. johnstoni,* Beddome; *C. denseplicata,* Verco; and *Scala* nepeanensis, Gatliff.

Genus **Cirsonella,** Angas 1877.

This includes the shells listed as *Cyclostrema weldii,* Ten.-Wds.; and *C. microscopica,* Gat. and Gab.

Genus **Lissotesta,** Iredale 1915.

This includes the shells listed as *Cyclostrema micra,* Ten.-Wds. (Iredale's genotype); *C. porcellana,* Tate and May; and *C. contabulatum,* Tate, var.

Genus **Orbitestella,** Iredale 1917.

This includes the shells listed as *Cyclostrema bastowi,* Gatliff (Iredale's genotype); and *C. mayi,* Tate.

Genus **Microdiscula,** Thiele 1912.

This includes the shell listed as *Cyclostrema charopa,* Tate.

Genus **Skenella,** Pfeffer 1886.

SKENELLA BRUNNIENSIS, Beddome.

1902. *Cyclostrema bruniensis,* Bedd. Prit. and Gat., these Proc., v. XIV., for 1901, p. 99.

The genus *Rissoa*, Fréminville, 1814, has also been greatly split up; we class ours already listed as follow:—

Genus **Haurakia,** Iredale 1915.

This includes the following species:—

HAURAKIA DESCREPANS, Tate and May.

1900. *Rissoa descrepans*, Tate and May. T.R.S., S.A., v. XXIV., p. 99.

1901. *Rissoa descrepans*, Tate and May. P.L.S., N.S.W., vol. XXVI., p. 391, pl. 26, f. 65.

1909. *Rissoa incompleta*, Hed. Gat. and Gab., these Proc., v. XXII., p. 41.

1918. *Haurakia descrepans*, Tate and May. Hed., Jour. R.S., N.S.W., v. LI., for 1917, p. 51, No. 498.

R. liddeliana, Hed., is also included in the genus *Haurakia*.

Genus **Merelina,** Iredale 1915.

This includes the shells listed as *Rissoa cheilostoma*, Ten.-Wds. (Iredale's genotype); *R. strangei*, Braz.; *R. hulliana*, Tate; *R. gracilis*, Ang.; *R. australiae*, Frauenf.; *R. agnewi*, Ten.-Wds.; and *R. filocincta*, Hed. and May.

Genus **Lironoba,** Iredale 1915.

This includes shells listed as *Rissoa tenisoni*, Tate; *R. imbrex*, Hed.; *R. schoutanica*, May; *R. iravadioides*, Gat. and Gab.; and *R. wilsonensis*, Gat. and Gab.

Genus **Estea,** Iredale 1915.

This includes the shells listed as *Rissoa subfusca*, Hutt. (Iredale's genotype); *R. incidata*, Frauenf.; *R. janjucensis*, Gat. and Gab.; *R. frenchiensis*, Gat. and Gab.; *R. woodsi*, Prit. and Gat.; *R. flammea*, Frauenf.; *R. pyramidata*, Hed.; *R. rubicunda*, Tate and May; *R. dubatabilis*, Tate; *R. bicolor*, Petterd; *R. erratica*, May; *R. salebrosa*, Frauenf.; *R. columnaria*, Hed. and May; *R. olivacea*, Dunker; *R. aurantiocincta*, May; *R. obeliscus*, May; also—

ESTEA TUMIDA, Tenison-Woods.

1876. *Diala tumida*, Ten.-Wds., P.R.S., Tas., p. 147.

1919. *Estea tumida*, Ten.-Wds. May, *Id*, p. 60, pl. 15, f. 9.

Hab.—Western Port.

Obs.—Size of type: Length 2.50, breadth 1 mm.

Estea kershawi, Tenison-Woods.

1877. *Rissoina kershawi,* Ten.-Wds., these Proc., v. XIV., p. 57.

1919. *Estea kershawi,* Ten.-Wds. May, P.R.S., Tas., p. 60, pl. 15, f. 11.

Hab.—Dredged in about 8 fathoms, off Rhyll, Western Port.

Obs.—Size of type: Length 3, breadth 1.33 mm.

Estea microcosta, May.

1919. *Estea microcosta,* May. P.R.S., Tas., p. 61, pl. 15, f. 12.

Hab.—Off Wilson's Promontory.

Obs.—Identification endorsed by the author, who remarks: "This is closely related to *E. kershawi.* It differs principally in the much more numerous and fine ribs, and rounder mouth and its rather more cylindrical form." Size of type: Length 2.5, breadth 1.2 mm.

Genus **Amphithalamus,** Carpenter 1863.

This includes our shells listed as *Rissoa approxima,* Petterd; *R. jacksoni,* Braz.; and *R. petterdi,* Braz.

Genus **Anabathron,** Frauenfeld 1867.

This includes the species listed as *Rissoa contabulata,* Frauenf.

Genus **Epigrus,** Hedley 1903.

This includes our shells listed as *Rissoa verconis,* Tate; *R. verconis,* Tate, var. *apicilata,* Gat. and Gab.; *R. dissimilis,* Watson.

Genus **Notosetia,** Iredale 1915.

This includes our shells listed as *Rissoa atropurpurca,* Dkr.; *R. atkinsoni,* Ten.-Wds.; *R. nitens,* Dkr.; *R. simillima,* May; *R. pellucida,* Tate and May; *R. pertranslucida,* May; and *R. melanochroma,* Tate.

Genus **Subonoba,** Iredale 1915.

This includes our shell listed as *Rissoa bassiana,* Hed.

Genus **Rissopsis,** Garrett 1873.

RISSOPSIS BREVIS, May.

1919. *Rissopsis brevis,* May. P.R.S., Tas., p. 63, pl. 16, f. 19.

Hab.—Bass Strait.

Obs.—Size of type: Length 2, breadth .8 mm.; a very small white shell.

Genus **Rissoina,** d'Orbigny 1840.

RISSOINA LINTEA, Hedley and May.

1908. *Rissoina lintea,* Hed. and May. Rec. Aust. Mus., v. VII., p. 17, pl. 22, f. 9.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Length 7, breadth 2.5 mm.

Genus **Rissolina,** Gould 1861.

RISSOLINA ANGASI, Pease.

This species was listed as a synonym of *Rissoina flexuosa,* Gould, owing to its wrongful identification by Prof. Tate. *R. flexuosa* is not a *Rissolina,* and according to Mr. Hedley is a synonym of *Rissoina fasciata,* Adams. *R. crassa,* Ang., is also included in the above genus.

Genus **Phasianella,** Lamarck 1804.

PHASIANELLA PERDIX, Wood.

1914. *Phasianella perdix,* Wood. Gat. and Gab., Vic. Nat., v. XXXI., p. 82.

Genus **Gabrielona,** Iredale 1917.

GABRIELONA NEPEANENSIS, Gatliff and Gabriel.

1908. *Phasianella nepeanensis,* Gat. and Gab., these Proc. v. XXI., pp. 366 and 379, pl. 21, f. 9, 10.

Iredale has selected this species as the genotype.

Genus **Astraea,** Bolten 1798, replaces *Astralium,* Link 1807.

ASTRAEA FIMBRIATA, Lamarck.

1822. *Trochus fimbriatus,* Lk. Anim. S. Vert., v. VII., p. 12.

1902. *Astralium squamiferum,* Koch. Prit. and Gat., these Proc., v. XIV., for 1901, p. 117.

The forms described under the two above names have been considered by some to be varying forms of one species; ours is that described by Lamarck.

Genus **Cantharidus,** Montfort 1810. (*Phasianotrochus,* Fischer 1885, is a synonym.)

CANTHARIDUS EXIMIUS, Perry.

This name replaces that listed as *Phasianotrochus carinatus,* Perry, who called it a *Bulimus,* and the name *B. carinatus* had been previously used by Bruguiere.

CANTHARIDUS NITIDULUS, Philippi.

1849. *Trochus nitidulus,* Phil. Conch. Cab., p. 295, No. 383, pl. 43, f. 10.

Hab.—Portland, and off cable to Tasmania, Bass Strait.

Genus **Calliostoma,** Swainson 1840.

CALLIOSTOMA ARMILLATUM, Wood.

1828. *Trochus armillatus,* Wood. Index Test. Supplement, pl. 5, f. 5.

1901. *Calliostoma meyeri,* Phil. Prit. and Gat., these Proc., v. XIV., p. 134.

Wood's name was not previously adopted, because there was no description of the shell. The rules of the International Congress now allow a binomial name, accompanied by a figure to be sufficient.

CALLIOSTOMA COMPTUM, A. Adams.

1913. *Calliostoma comptum,* A. Ad. Hed., P.L.S., N.S.W., v. XXXVIII., p. 279.

This species was listed as *C. poupineli,* Montr., from New Caledonia. Upon consulting the original description of that species we find that it is distinct from ours.

Genus **Cantharidella,** Pilsbry 1889.

This genus includes the shell listed as *Gibbula tiberiana,* Crosse.

Genus **Calliotrochus,** Fischer 1880.

This includes the shells listed as *Gibbula tasmanica,* Petterd; *and G. legrandi,* Petterd.

Genus **Haliotis,** Linnaeus 1758.

HALIOTIS ROEI, Gray.

1826. *Haliotis roei,* Gray. King's Survey of Australia, pp. 157 and 493.

1846. *Haliotis roei,* Gray. Rve., Conch. Icon., v. III., pl. 4, f. 10.

1859. *Haliotis roei,* Gray. Chenu, Man. Conch., v. I., p. 367, f. 2739 and 2740.

Hab.—Portland.

Genus **Megatebennus,** Pilsbry 1890.

MEGATEBENNUS JAVANICENSIS, Lamarck.

1914. *Megatebennus javanicensis,* Lk. Gat. and Gab., Vic. Nat., v. XXXI., p. 82.

Genus **Diodora,** Gray 1821, replaces *Fissuridea,* Swainson 1840.

Genus **Montfortula,** Iredale 1915.

This includes the species listed as *Subemarginula emarginata,* Bl.; and *S. rugosa,* Quoy and Gaim.

Genus **Scutus,** Montfort 1810.

SCUTUS ANTIPODES, Montfort.

1810. *Scutus antipodes,* Montf. Conch, Syst., v. II., p. 58, pl. 15.

1902. *Scutus anatinus,* Donovan. Prit. and Gat., these Proc., v. XV., p. 188.

1917. *Scutus antipodes,* Montf. Hed., P.L.S., N.S.W., v. XLI., for 1916, p. 704, pl. 47, f. 7-9.

Genus **Tugalia,** Gray 1843.

TUGALIA CICATRICOSA, A. Adams.

1852. *Tugali cicatricosa,* A. Ad. P.Z.S., Lond. for 1851, p. 89.

1863. *Tugalia cicatrosa,* A. Ad. Sowb., Thes. Con., v. III., p. 222, pl. 14, f. 14.

1865. *Tugalia cicatricosa,* A. Ad. P.Z.S., Lond., p. 185.

1870. *Tugalia cicatrosa,* A. Ad., Rve. Conch. Icon., v. XVII., pl. 1, f. 7.

1890. *Tugalia cicatricosa,* A. Ad. Tryon, Man. Conch., v. XII., p. 285, f. 86, *not* 85.

1917. *Tugalia cicatricosa,* A. Ad. Hed., P.L.S., N.S.W., v. XLI., p. 698, for 1916.

Hab.—Dredged with the animal, Half Moon Bay, Port Phillip, also Western Port.

Obs.—Tryon's fig. 86 *loc. cit.* is a copy of that in Thes. Conch., and is referred to in the text and table of the plate as 86, but on the plate is wrongly numbered 85, and that of *T. carinata* 86, evidently a reversal, in error. Hedley's fig. 26, plate 52 *loc. cit.* does not represent the species. He states: "A scar on the summit, which suggested the name, was an individual and accidental feature of the type shell. It is by chance repeated in a specimen before me, and was probably caused by adherence of a *Capulus,* or some such associate."

We have obtained over 20 specimens, some of them dredged with the animal, all with the summit free from any encumbrance, and we also have similar specimens from South Australia, and cannot agree with Hedley's surmise.

The habitat of the type is given as Philippine Islands; it is more coarsely sculptured than as we find it.

Genus **Cellana,** H. Adams 1869, replaces *Helcioniscus,* Dall 1871.

CELLANA VARIEGATA, Blainville.

1825. *Patella variegata,* Bl. Dict. Sci. Nat., v. XXXVIII., p. 100.

1908. *Helcioniscus diemenensis,* Phil. Gat. and Gab., these Proc., v. XXI., p. 382.

1915. *Helcioniscus variegatus,* Bl. Hed., P.L.S., N.S.W., v. XXXIX., for 1914, p. 714.

Genus **Patella,** Linnaeus 1758.

PATELLA VICTORIAE, Gatliff and Gabriel, nom. mut.

1902. *Patella hepatica,* Prit. and Gat., not of Gmelin, these Proc., v. XV., p. 194.

PATELLA SQUAMIFERA, Reeve.

1902. *Patella aculeata,* Rve., not of Gmelin, Prit. and Gat. *Id.*, p. 193.

Genus **Nacella,** Schumacher 1817.

NACELLA PARVA, Angas.

1878. *Nacella parva,* Ang. P.Z.S., Lond., p. 862, pl. 54, f. 12.

1912. *Nacella parva,* Ang. Verco, T.R.S., S.A., v. XXXVI., p. 183.

Hab.—Portland.

Obs.—Found living on the seaweed *Cymodocea antarctica,* associated with *Nacella stowae,* Verco, and *Stenochiton cymodocealis,* Ashby. A rather constant feature is: "A single row of pale blue spots and crescent-shaped opaque markings extending from the apex centrally, more or less along the outer arc of the shell." Size of type: Diam. maj. 6, min. 3, alt. 2mm.

Genus **Patelloida,** Quoy and Gaim. 1834, replaces (*Acmae* Eschscholtz, 1828, not of Hartman 1821.

Genus **Callochiton,** Gray 1847.

CALLOCHITON MAYI, Torr.

1912. *Callochiton mayi,* Torr. P.R.S., Tas., p. 1.

1912. *Callochiton mayi,* Torr. May and Torr, *Id.* p. 28, pl. 1, f. 5-7.

1912. *Callochiton mayi,* Torr. T.R.S., S.A., v. XXXVI., p. 164, pl. 5, f. 1a-f.

Hab.—Portland.

Obs.—Size of type: Length 15, breadth 8 mm. A beautifully ornate little species. The girdle, with its dense microscopic diamond-shaped scales, longitudinally-sulcate pleural areas. and dots on the lateral areas, serve as useful recognition marks.

CALLOCHITON RUFUS, Ashby.

1900. *Callochiton rufus,* Ashby. T.R.S., S.A., p. 87, pl. 1, f. 2a-g.

1921. *Callochiton rufus,* Ashby, these Proc., v. XXXIII., for 1920, p. 150.

Hab.—Port Phillip Heads (J. B. Wilson).

Obs.—Size of type: Length 16, breadth 10 mm. Ashby *loc. cit.* says this was misidentified by Sykes as *C. platessa,* Gould.

Genus **Stenochiton,** Adams and Angas 1864.

STENOCHITON CYMODOCEALIS, Ashby.

1918. *Stenochiton cymodocealis,* Ashby. T.R.S., S.A., v. XLII., p. 70, pl. 13-14, f. 1, 4, 5, 11, 12.

Hab.—Portland.

Obs.—Size of type: Length 10, breadth 3.5 mm.; found on the seaweed *Cymodocea antarctica.*

Genus **Ischnochiton,** Gray 1847.

ISCHNOCHITON DECUSSATUS, Reeve.

1847. *Chiton decussatus,* Rve. Conch. Icon., sp. 107, pl. 18, f. 107, also pl. of "Details of sculpture," f. 107.

Hab.—Portland.

Obs.—Dr. Torr has erroneously placed this species as a synonym of *Chiton sulcatus,* Q. and G. They differ distinctly. Quoy and Gaimard's name is not available, as in 1815, in General Conchology, p. 16, pl. 3, f. 1, Wood described and figured a different shell under that name, and it is quoted by Dillwyn in his Cat. Recent Shells, p. 8.

ISCHNOCHITON IREDALEI, Dupuis.

1917. *Ischnochiton lineolatus,* Iredale and May; not of Blainville, Gat. and Gab., these Proc., v. XXX., p. 26.

1918. *Ischnochiton iredalei,* Dup. Bull. Mus. Hist., Nat., No. 7.

1921. *Ischnochiton iredalei,* Dup. Ashby, these Proc., v. XXXIII., for 1920, p. 151.

1921. *Ischnochiton iredalei,* Dup. Ashby, T.R.S., S.A., v. XLIV., for 1920, p. 284.

Obs.—This is *I. contractus,* auct. not of Reeve.

Genus **Plaxiphora,** Gray 1847.

PLAXIPHORA BEDNALLI, Thiele.

1909. *Plaxiphora glauca,* Quoy and Gaim. Gat. and Gab., these Proc., v. XXII., p. 42.

1909. *Plaxiphora bednalli,* Thiele. Revision des Systems des Chitonen, p. 25, pl. 3, f. 27-31.

Obs.—This species was identified by Bednall as *P. glauca,* Q. and G., and he sent a specimen to Thiele, who said it was not that species, and named it *P. bednalli.*

PLAXIPHORA COSTATA, Blainville.

1825. *Chiton costata,* Bl. Dict. Sci. Nat., vol. XXXVI., p. 548.

1893. *Chiton costatus,* Bl. Pilsbry, Man. Conch., v. XV., p. 105.

1902. *Plaxiphora petholata,* Sowerby. Prit. and Gat., these Proc., v. XV., p. 204.

Genus **Acanthochitona,** Gray 1821, replaces *Acanthochites,* Risso 1826.

ACANTHOCHITONA COSTATA, Adams and Angas.

1864. *Acanthochites costatus,* Ad. and Ang. P.Z.S., Lond., p. 194.

1893. *Acanthochites costatus,* Ad. and Ang. Pilsbry, Man. Conch., v. XV., p. 40, pl. 3, f. 74.

Hab.—Portland.

Obs.—Size of type. Length 18, breadth 7 mm. This was obtained in New South Wales; it is also recorded in Queensland; South Australia; and Tasmania.

ACANTHOCHITONA GATLIFFI, Ashby.

1919. *Acanthochiton gatliffi,* Ashby. T.R.S., S.A., v. XLIII., p. 398, pl. 42, f. 2-5.

1921. *Acanthochiton gatliffi,* Ashby. These Proc., v. XXXIII., for 1920, p. 152.

Hab.—Dredged off Point Cook, Port Phillip, in 8 fathoms.

Obs.—Size: Length 6, breadth 3 mm.

ACANTHOCHITONA TATEI, Torr and Ashby.

This proves to be a synonym of *A. granostriatus,* Pilsbry.

Genus **Rhyssoplax,** Thiele 1893.

Under this new genus are now classed the species listed as *Chiton bednalli,* Pilsbry; *C. tricostalis,* Pilsbry; *C. jugosus,* Gould; *C. exoptanda,* Bednall; *C. verconis,* Torr and Ashby; and *C. calliozona,* Pilsbry.

CHITON LIMANS, Sykes.

This name drops, and must be deleted from our list. It had been revived by Sykes, but as Ashby has pointed out in his report on the Bracebridge Wilson collection of Chitons in the National Museum, dealt with by Sykes, the shells there to which the name of *C. limans* was given proved to be *C. tricostalis,* Pilsbry.

There will be other alterations made in the nomenclature of the Polyplacophora not yet definitely decided upon. Ashby and other workers are dealing with the subject.

Genus **Rhizorus,** Montfort 1810, replaces *Volvulella,* Newton 1891.

Genus **Cylichnella,** Gabb 1873, replaces *Bullinella,* Newton 1891.

Genus **Bullaria,** Rafinesque, replaces *Bulla,* Linne 1767.

Genus **Ringicula,** Deshayes 1838.

RINGICULA GRANDINOSA, Hinds.

1844. *Ringicula grandinosa,* Hinds. P.Z.S., Lond., p. 96.
1878. *Ringicula grandinosa,* Hinds. Braz. P.L.S., N.S.W., v. II., p. 78.
1893. *Ringicula grandinosa,* Hinds. Pilsbry, Man. Conch., v. XV., p. 409, pl. 47, f. 72.

Hab.—Port Albert (Worcester).

Obs.—A stout shell, whorls rounded. "The last large, subquadrate, rotund."

Genus **Tethys,** Linné 1758, replaces *Aplysia,* Linne 1767.

Genus **Kerguelenia,** Mabille and Rochebrune 1887.

This genus includes *Siphonaria stowae,* Verco, previously listed.

Genus **Gadinia,** Gray 1824.

GADINIA CONICA, Angas.

1867. *Gadinia conica,* Ang. P.Z.S., Lond., pp. 115 and 220, pl. 13, f. 27.

This name replaces that for the shell listed as *G. angasi,* Dall.

Genus **Dentalium,** Linnaeus 1758.

DENTALIUM ERECTUM, Sowerby.

1860. *Dentalium erectum,* Sowb. Thes. Conch., v. III., p. 99, pl. 13, f. 55.

Hab.—Taken off cable to Tasmania, Bass Strait.

Genus **Dacosta,** Gray 1858.

This includes the species listed as *Clavagella australis,* Lk.

Family LATERNULIDAE replaces Anatinidae.

Genus **Laternula,** Bolten 1798, replaces *Anatina,* Lamarck 1809.

Genus **Myodora,** Gray 1840.

MYODORA ANTIPODUM, E. A. Smith.

1880. *Myodora antipodum,* E. A. Smith. P.Z.S., Lond., p. 585, pl. 53, f. 7, 7a.

1913. *Myodora antipodum,* E. A. Smith. Suter, Man. N.Z. Moll., p. 1027, pl. 55, f. 10a.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Length 9, width 13.33, diam. 2 mm. Smith compares it with *M. pandoriformis,* Stutch.

Genus **Thraciopsis,** Tate and May 1900.

THRACIOPSIS SPECIOSA, Angas.

1869. *Thracia speciosa, Ang.* P.Z.S., Lond., p. 48, pl. 2, f. 12.

Hab.—Frankston, Port Phillip. Dredged Western Port.

Obs.—Size of type: Long. 23, alt., 12, lat. 6 mm.

Genus **Anapella,** Dall 1895.

ANAPELLA TRIQUETRA, Hanley.

1914. *Anapella triquetra,* Han. Gat. and Gab., Vic. Nat., v. XXXI., p. 82.

Genus **Syndesmya**, Recluz 1843.

SYNDESMYA EXIGUA, H. Adams.

1903. *Semele exigua*, H. Ad. Prit. and Gat., these Proc., v. XVI., p. 113.

1914. *Syndesmya exigua*, H. Ad. Lamy, Jour. de Conch. for 1913, v. LXI., p. 294, pl. 8, f. 4-6.

Genus **Gari**, Schumacher 1817.

GARI LIVIDA, Lamarck.

1818. *Psammobia livida*, Lk. Anim. S. Vert., v. V., p. 515.

1818. *Psammotea zonalis*, Lk. *Id.* p. 517.

1903. *Gari zonalis*, Lk. Prit. and Gat., these Proc., v. XVI., p. 113.

1914. *Psammobia, livida*, Lk. Dautz. and Fisch., Jour. de Conch. for 1913, v. LXI., p. 224, pl. 7, f. 4-6; and they state that *P. zonalis* is a synonym.

Genus **Pseudoarcopagia**, Bertin 1878

PSEUDOARCOPAGIA VICTORIAE, Gatliff and Gabriel.

1914. *Tellina (Arcopagia) victoriae*, Gat. and Gab., Vic. Nat., v. XXXI., p. 83.

Genus **Hemidonax**, Morch 1870.

HEMIDONAX AUSTRALIENSE, Reeve.

1914. *Hemidonax australiense*, Rve. Gat. and Gab., Vic. Nat., v. XXXI., p. 83.

Genus **Donax**, Linnaeus 1758.

DONAX SORDIDUS, Reeve.

1845. *Donax sordidus*, Rve. Ann. and Mag. Nat. Hist., v. XVI., p. 59.

1848. *Donax sordida*, Rve. Krauss Sudafr. Moll., p. 6, pl. 1, f. 4.

1854. *Donax sordidus*, Rve. Conch. Icon., v. VIII., pl. 5, f. 32.

Hab.—Portland.

Obs.—Size of our shell: Antero-posterior diameter 23, umbo-ventral diam. 16 mm.

Genus **Lioconcha,** Morch 1883.

This includes the species listed as *Circe angasi,* E. A. Smith.

Genus **Callanaitis,** Iredale 1917.

CALLANAITIS DISJECTA, Perry.

1903. *Chione disjecta,* Perry. Prit. and Gat., these Proc., v. XVI., p. 122.

1913. *Chione disjecta,* Perry. Suter, Man. N.Z. Moll., p. 989, pl. 61, f. 5.

Genus **Katelysia,** Romer 1857.

This includes the species listed as *Chione strigosa,* Lk.; *C. scalarina,* Lk.; and *C. peronii,* Lk.

Genus **Clausinella,** Gray 1851.

This includes the species listed as *Chione placida,* Phil.

Genus **Gomphina,** Morch 1853.

GOMPHINA UNDULOSA, Lamarck.

1914. *Gomphina undulosa,* Lk. Gat. and Gab., Vic. Nat., v. XXXI., p. 83.

Genus **Macrocallista,** Meek 1876.

This includes the species listed as *Meretrix disrupta,* Sowb.; *M. planatella,* Lk.; *M. kingii,* Gray; and *M. regularis,* Smith.

Genus **Bassina,** Jukes-Browne 1914.

This includes the species listed as *Meretrix paucilamellata,* Dkr., and Jukes-Browne selects it as the genotype.

Genus **Pullastra,** Sowerby 1826.

This includes the species listed as *Tapes fabagella,* Desh., and *Tapes galactites,* Lk.

Genus **Myrtaea,** Turton 1822.

MYRTAEA BOTANICA, Hedley.

1903. *Lucina brazieri, Sowb.* (*as Tellina*), Prit. and Gat., these Proc., v. XVI., p. 138, not *T. brazieri,* Sowb., 1869.

1918. *Myrtaea botanica,* Hed. *nom. mut.* J.R.S., N.S.W., v. LI., for 1917, p. 18, No. 177.

This genus also includes the species listed as *Lucina mayi,* Gat. and Gab.

Genus **Codakia,** Scopoli 1777.

This includes the species listed as *Lucina minima,* Ten.-Wds.; *L. paupera,* Tate; and *L. tatei,* Ang.

Genus **Divaricella,** Von Martens 1880.

DIVARICELLA CUMINGI, A. Adams and Angas.

1863. *Lucina (Cyclas) cumingi,* Ad. and Ang., P.Z.S., Lond., p. 426, pl. 37, f. 20.

1903. *Lucina (Divaricella) huttoniana,* Vanatta. Prit. and Gat., these Proc., v. XVI., p. 139.

1913. *Divaricella cumingi,* A. Ad. and Ang. Suter, Man. N.Z. Moll., p. 913, pl. 58, f. 18.

This is the species listed by Tenison-Woods in his Tasmanian Census of Marine Shells as *Lucina divaricata, L.*

Genus **Cyamiomactra,** Bernard 1897.

CYAMIOMACTRA BALAUSTINA, Gould.

1861. *Kellia balaustina,* Gould. Proc. Bost. Soc. Nat. Hist., v. VIII., p. 33.

1909. *Cyamiomactra nitida,* Hed. Gat. and Gab., these Proc., v. XXII., p. 45.

1914. *Cyamiomactra balaustina,* Gould. Gat. and Gab., Vic. Nat., v. XXXI., p. 84.

1915. *Cyamiomactra balaustina,* Gould. Hed., P.L.S., N.S.W., p. 699, pl. 77, f. 2, 3.

Genus **Coriareus,** Hedley 1907.

This includes the shell listed as *Montacuta semiradiata,* Tate.

Genus **Condylocardia,** Bernard 1896.

CONDYLOCARDIA SUBRADIATA, Tate.

1888. *Carditella subradiata,* Tate, T.R.S., S.A., v. XI., p. 62, pl. 11, f. 7.

1908. *Condylocardia subradiata,* Tate. *Id.* v. XXXII., p. 358, pl. 17, f. 25-28.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Antero-posterior diam. 13, umbo-ventral diam. 12.5 mm.

Genus **Venericardia,** Lamarck 1801.

VENERICARDIA ROSULENTA, Tate.

1887. *Cardita rosulenta,* Tate. T.R.S., S.A., v. IX., p. 69, pl. 5, f. 3.

1911. *Venericardia rosulenta,* Tate. Hed. Zool. Commonwealth trawler *Endeavour,* v. I., p. 97, pl. 17, f. 4.

Hab.—Taken off cable to Tasmania, Bass Strait.

Obs.—Size of type: Antero-posterior diam. 21, umbo-ventral diam. 17 mm. Hedley records, *loc. cit.,* a specimen 45 mm. in length.

The shells listed as *Cardita* are now classed as *Venericardia,* and the genus *Cardita* is now used for those species previously listed as *Mytilicardia.*

Genus **Neotrigonia,** Cossmann 1918.

This includes the shell listed as *Trigonia margaritacea,* Lk.

Genus **Nuculana,** Link 1807, replaces *Leda,* Schumacher 1817.

NUCULANA DOHRNI, Hanley.

1861. *Leda dohrni,* Han. P.Z.S., Lond., p. 242.

1871. *Leda dohrnii,* Han. Sowb., Conch. Icon., v. XVIII., pl. 9, f. 54.

Hab.—Taken off cable to Tasmania, Bass Strait.

The genus *Nuculana* includes the species already listed as *Leda.*

Genus **Modiolus,** Lamarck 1799.

This replaces *Modiola,* Lk., and the species listed as such will be changed accordingly.

Genus **Musculus,** Bolten 1798, replaces *Modiolaria* Loven 1846.

Genus **Pinctada,** Bolten 1798.

This includes the shell listed as *Meleagrina margaritifera,* L.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. II., 1921].

Art. XVI.—*Gold Specimens from Bendigo and their Probable Modes of Origin.*

By F. L. STILLWELL, D.Sc.

(Plate I.)

[Read November 10th, 1921].

The gold in the Bendigo quartz reefs occurs as particles of bright, yellow, free gold, of high quality, containing about 30 parts per 1000 of silver. Its occurrence can be divided into two general types—

(a) As particles associated with the dark laminated seams traversing the quartz;

(b) as particles embedded in white quartz.

While these two general types are not confined to any particular form of reef, it can be said that the first type is more characteristic of saddle reefs and leg reefs, and that the second type is more characteristic of "spurs," which are veins cutting across the strata. The gold particles in the spurs are, on an average, larger than the gold particles associated with the carbonaceous seams, but the latter may be more numerous, and have formed the main factor in the richest saddle reefs of Bendigo. Such particles are occasionally so numerous as to form a sheet of gold along the lamina.[1]

The particles of gold embedded in white quartz appear as shotty specks, or as sheeted interlacings with quartz, and sometimes ankerite. The gold particles, like quartz, are allotriomorphic, and do not assume their crystalline form except in rare cases in vugs. The tendency of the gold towards its crystalline form is, however, often sufficient to produce more or less rounded, shotty particles, unless there exist obstructing or modifying circumstances. The shotty particles sometimes are readily loosened and detached from the quartz, and are then spoken of as "loose gold." The modifying circumstances may develop during the later stages of growth of a vein if the quartz crystals grow at a more rapid rate than the gold crystals, or if the growth of the

1. Gold Deposition in the Bendigo Goldfield. F. L. Stillwell, Bull. 4, Commonwealth Adv. Council of Sci. and Ind., plate III., fig. 2.

quartz crystals continues for a longer period than required for the gold crystals. The tremendous crystallising pressure of the quartz, which is sufficient to force apart the walls of the vein, may then be partially directed against the growing crystals of gold, modifying them in the same way that gold is hammered in the production of gold leaf. In this case the final result is a sheeted interlacing of gold with quartz, ankerite, and other minerals, with an appearance that has often suggested the infiltration of secondary gold in cracks in a quartz vein.

The specimen illustrated in Fig. 1 came from the Constellation saddle reef above the 622 feet level. It shows a black slaty seam, partly mixed with ankerite, pursuing its normal tortuous track through the quartz. Several particles of gold, pyrite and galena occur in this specimen along this carbonaceous seam, including a well-formed cube of pyrite. Particles of gold are embedded in the cube of pyrite, and appear to have formed the nucleus of the crystal.

Another specimen, occurring near this cube in the same saddle reef, shows an intimate mixture of gold, galena and pyrite. The mixture borders upon a carbonaceous lamina, visible on the side of the specimen, but which is not revealed in the photograph (fig. 2). The photograph illustrates a sliced surface of the specimen on which only a few fragments of carbonaceous matter are showing, but pyrite (P), gold (white), and galena (Ga) are distinguishable. The mass of pyrite is embedded in quartz, but at the same time it is broken by veins of quartz, galena and gold. The gold appears not only as nuclei of some of the pyrite, but also as a network of veins in the pyrite, and in the galena.

Without consideration of the process of formation of the vein, the petrographical relations of the quartz and pyrite in these two specimens would indicate that—(1) pyrite crystallised before gold, and (2) that gold crystallised before pyrite. The apparently contradictory character of these conclusions appears to me to disappear when the vein is viewed as a slow and steady growth, in which the quartz and each other mineral are slowly and continuously deposited from the initial stages up to the final stages of the formation of the vein. The gold, pyrite and galena are localised in the quartz in these instances, partly by the precipitating action of the slaty residues, and, in a growing mixture of gold and pyrite, some of the pyrite may be precipitated before some of the gold, and some of the gold before some of the pyrite. The mutual relationships of the solubilities and concentrations of the different vein minerals, which might have been expected to produce a more or less characteristic order of deposition have been disturbed by the presence of foreign precipitating matter.

A specimen of a different and rare type at Bendigo is illustrated in Fig. 3. It consists of a thin plate of gold, with a small fragment of attached quartz, terminating in a crystal of gold. The specimen is 3 cm. long, weighs 2 dwts. 14 grs., and is shown in the photograph with a magnification of 2. It was found in a quartz spur in sandstone about two feet wide in the stopes on the Victory spurs, 580 feet south, 1235 feet level, in the Carlisle mine. The gold crystal occurred in a vug, terminating the plate of gold in the same way as the associated quartz crystals in the same vug grew out from the mass of quartz. The dominating faces of the crystal are those of the octahedron. The solid angles of the octahedron are replaced by small faces of the cube, and the edges of the octahedron are replaced by faces of the rhombicdodecahedron. For nearly 1cm. behind the terminating crystal, crystalline faces of gold can be seen on the plate of gold. It is quite clear that this small nugget of gold is as essential and primary a part of the vein as the quartz crystals that form the bulk of the vein. Had the gold not assumed the platy and crystalline form, the occurrence might have been similar to the gold wire whose occurrence in a quartz vug has previously been recorded.[2]

Another rare specimen obtained from the same stopes, at the 1235 feet level, in the Carlisle mine, is illustrated in Fig. 4. This is a fragment of a very small, but very rich, spur, which traversed a thick bed of slates on the eastern side of the stopes. The thickest part of the vein in the specimen is 5 mm., in which are embedded two isolated crystals of sphalerite, with a little admixed pyrite. A few small specks of gold are embedded in the quartz, but the main mass of gold in the specimen occurs as a thin film, bounding the quartz and the slate. The gold film shows irregularities, but is fairly continuous, and, when the slate is broken away, has the appearance of gold paint on the wall of the vein. Towards one end of the specimen the thick-

2. The Factors Influencing the Deposition of Gold in the Bendigo Goldfield. F. L. Stillwell, Bull. No. 8, Adv. Council of Sci. and Industry, plate V., fig. 2.

ness of the quartz vein diminishes, and becomes almost pure gold. An interesting feature of the specimen is shown in the illustration, and consists of a number of gold platy riffles standing out from the vein at right angles to the wall. These riffles are on the whole parallel to the cleavage of the slate, and represent gold that has been deposited in the cleavage cracks from solutions traversing the course of the vein. The feature exists on both sides of the vein. It is very clear from this specimen that the slate has been a precipitating agent for the gold.

Another specimen from the same gold shoot, and the same mine, can also be recorded, though it does not lend itself to illustration. It was obtained from the 1264 feet level, adjoining the plane of a small west dipping fault. A spur, which varies in thickness from ½ inch to 1½ inches, butts against the fault plane, and contains pyrite and colours of gold. Projecting from the wall of a small branching spur, which forms the fault plane, is a nest of pyrite cubes, and the wall of the fault and spur is mostly covered with a film of gold, which also extends into the fractures of the associated slate. These two specimens are rare, and at first glance the films of gold paint suggest the occurrence of secondary gold, i.e., gold which has been leached from the gold-bearing spurs, and precipitated by the slate. The small fault is believed to have existed prior to the vein formation, and gold might have been precipitated from the primary solutions circulating along it, or from subsequent secondary solutions. The great depth of the occurrence of 1264 feet below the surface is a fact in strong opposition to a theory of downward secondary enrichment, while the association of the gold with the sulphides is more consistent with its being of primary origin. Even if it were claimed that these occurrences indicate the presence of secondary gold, it must be remembered that they are rare. Frequent inspections of mining operations on this gold shoot in the Carlisle mine, which, during the fourteen months preceding September, 1921, produced 15,712 ounces of gold, valued at £84,761, failed to yield any evidence recognisable as being characteristic of secondary enrichment. It may therefore be fairly concluded that the gold in the spurs is primary, and that the existence of the gold shoot is dependent on primary causes.

PLATE I.

Fig. 1. Quartz, showing gold (dark), embedded in a cube of pyrite. From saddle reef above 622 feet level, Constellation mine. Mag. 2.

Fig. 2. Quartz carrying pyrite gold and galena. The pyrite (P) is intersected by veins of quartz, galena (Ga) and gold (white). From saddle reef above 622 feet level, Constellation mine. Mag. 2.

Fig. 3. Thin plate of gold terminating in a crystal of gold. Stopes 580 feet south, 1235 feel level, Carlisle mine. Mag. 2.

Fig. 4. Rich spur in slate, showing a number of gold platy riffles standing out from the vein at right angles to the wall of the spur. The dark area (B) is a crystal of zinc blende embedded in the vein, and the hackly appearance of the edge of the vein is due to gold. Eastern side of stopes, 580 feet south, 1235 feet level, Carlisle mine. Mag. 2.

Fig. 1.

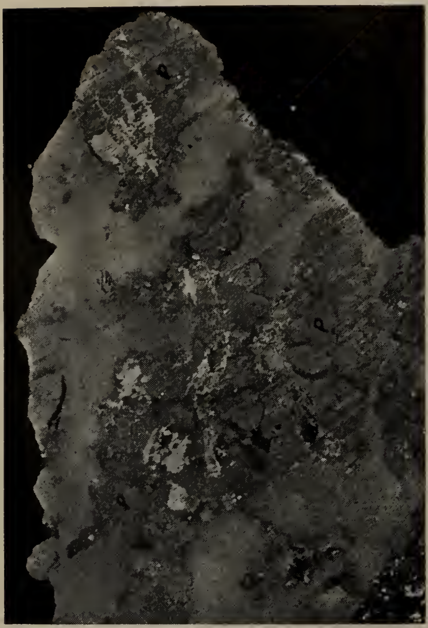


Fig. 2.

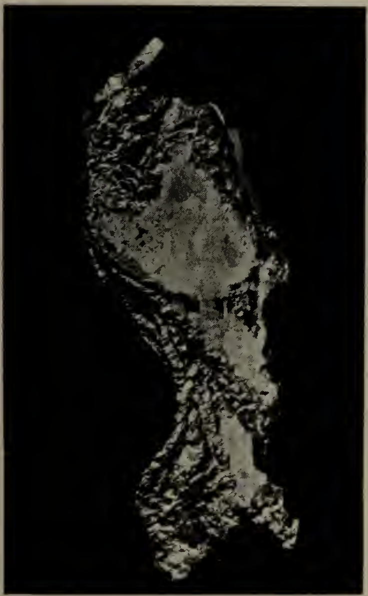


Fig. 3.

Fig. 4.

[Proc. Roy. Soc. Victoria, 34 (N.S.), Pt. II., 1922.]

Art. XVII.—*On a Fossil Filamentous Alga and Sponge-Spicules forming Opal Nodules at Richmond River, N.S.W.*

By FREDERICK CHAPMAN, A.L.S., F.R.M.S.

(With Two Text Figures.)

[Read 10th November, 1921.]

Source of Specimens.

The samples of common opal from the diatomaceous deposits of the Richmond River at Tintenbar, New South Wales, now described, were handed over to the National Museum Collection by Mr. R. H. Walcott, Curator of the Technological Museum, Melbourne. They were received by Mr. Walcott from Mr. G. N. Milne, of the Salvation Army, at Bayswater, on the 18th of December, 1919.

In response to Mr. Walcott's desire to know something of the microscopic nature of these samples, I took thin slices from two of the pieces, which gave different results; in the one case a spicule-rock being revealed, originating from freshwater sponges, and in the other the matted thalli of a confervoid freshwater weed, probably of the genus *Cladophora,* and now silicified.

Literary Notes on the Deposit.

Professor Liversidge, writing on the siliceous deposits from the Richmond River, New South Wales,[1] refers to this rock as resembling "the deposits thrown down by hot springs or geysers." He records the presence of wood opal and remains of ferns (Pteris) and seeds, one of the latter being named by von Mueller, *Liversidgea oxyspora,*[2] to which is also referred a leaf fragment.

J. Milne Curran, in writing on precious stones in New South Wales,[3] on p. 258 of the reference quoted, says, "I have more than once received specimens of diatomite from the Richmond River, which were in part converted into a true opal."

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1. Journ. and Proc. R. Soc. N.S. Wales, vol. X. (1876), 1877, pp. 237-240.
2. Loc. cit., p. 239, plate.
3. Journ. and Proc. R. Soc., N.S. Wales, vol. XXX (1896), 1897.

The most important contribution on the diatom deposit of the Richmond River is that by Messrs. G. W. Card and W. S. Dun.[4] A copious quotation bearing on the present work is as follows:—

"Wyrallah.—The deposits on the Richmond River appear to be typically developed at Wyrallah, nine miles from Lismore. Here there seems to be a number of scattered deposits on either side of the Richmond River. They are surrounded and overlain by scoriaceous basalt, and occur in depressions in the same rock. Probably large areas of the diatomaceous earth have been washed away. It has been stated at various times that considerable thicknesses of the earth exist in private lands, but this requires confirmation. The physical character of the diatomaceous earth from these deposits is peculiar. It is hard and stony, requiring considerable pressure to crush it, and it is of a dirty white colour. The percentage of silica is high—over 90 per cent., and the lower portion of the deposit merges into a band of yellowish common opal, about a foot thick. Pieces of the opaline rock are marginally earthy, due probably to the removal by solution of the secondary silica, as in the case of chalk flints. The rock is isotropic, and marked with parallel bands, coloured by splashes of yellow and brown.[5] With a high magnifying power the base is seen to be made up of hazy wisps and shreds, and numerous indistinct fragments of *Melosira*. This has been remarked on by the Rev. J. Milne Curran."[6]

Some interesting "Notes on a Plant-bearing Common Black Opal from Tweed Heads, N.S.W."[7] have been published by Prof. E. W. Skeats. The opal occurs associated with basalt flows, and, although the age of the basalt is left open by Prof. Skeats, yet the occurrence of the freshwater algae in the opal at any rate points to similar conditions of deposition that we infer from the opal of the Richmond River now under discussion. It will be here appropriate to quote part of the remarks of Prof. Ewart upon the structures found in the opal, recorded on p. 21 of Prof. Skeats' paper: "Some of the structures appeared to represent sections of fresh-water algae, others of various plants, including the spore of a fungus, a transverse section of a leaf, and, possibly, a section of a small petiole."

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4. Rec. Geol. Surv. N.S. Wales, vol. V., pt. 3, 1897, pp. 143 and 144.
5. This description applies to the present specimens.
6. "This" refers to the opal, and not to its contents, as a reference to Mr. Curran's paper will show.
7. Proc. Roy. Soc., Queensland, vol. XXVI., 1914, pp. 18-22, pls. I. and II.

Description of Thallophyte.

The appearance of this organism in a thin section under a moderate magnification (1 inch obj.) is that of a matted, filamentous weed, reminding one of the threadlike conferva of lakes and streams. The filaments are usually cylindrical, and

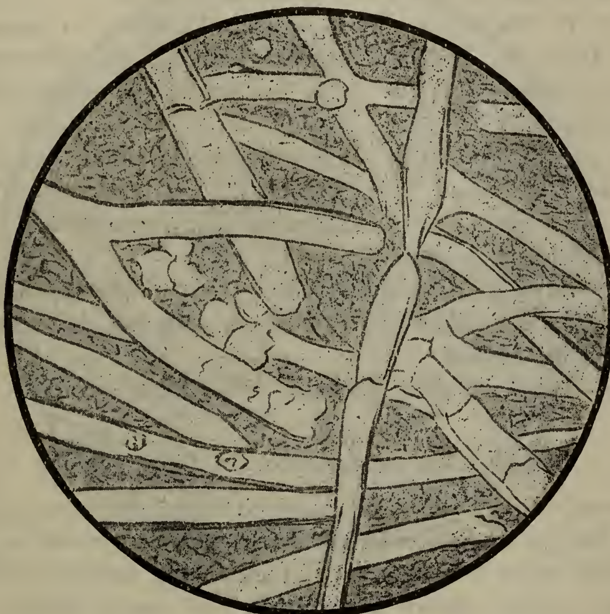

Fig. 1 *Cladophora richmondiensis,* sp. nov.

constricted at the nodes or partitions. The partitions are spaced at fairly long intervals, varying from about three to six times the diameter of the filament. The cell-walls show a well marked outline of the exterior and interior, which character distinguishes them at once from any spicular body, in which there is a strong surface refraction.

Small rounded bodies in aggregates are seen in the matrix, which may be referable to tetraspores. The average diameter of the cells of the thallus measure 46 μ.

That this fossil form is of the confervoid type of cell-structure, and not referable to the blue-green algae, is very clear from the distinctness of the cell-walls, which are sharply outlined and not hazy as in the encrusted cells of the *Cyanophyceae.*

The occurrence of this fossil confervoid is of especial interest on account of the rarity of fossil remains of this character. Impressions of confervoid-like structures in rocks were named *Confervites* by Brongniart in 1828.

Bornemann also described a Cambrian fossil from Sardinia, to which he gave the name of *Confervites chantransioides;* the filaments of this fossil have a diameter of 6-7 μ.[8]

Dr. C. D. Walcott has lately described a genus of algae, *Marpolia,*[9] from the Middle Cambrian shale of the Burgess Pass Quarry, British Columbia. This form closely resembles the habit of growth in *Cladophora,* though no actual structure of the thallus was determinable. It is relatively larger in size than the form here described from the opal. Dr. Walcott refers the genus *Marpolia* to the *Cyanophyceae,* but a comparison is made with *Cladophora* (*Chlorophyceae*).

Some forms of the *Codiaceae* are also filamentous and branching, and are not unknown in fossil deposits, but these appear to be of marine habitat.

Age.—Late Cainozoic; probably Pleistocene.

Description of Spicules in Opal (Fig. 2).

The majority of the spicules found in one specimen examined are of the typical *Spongilla* type, being straight, curved or slender fusiform; some are nearly cylindrical and pointed at the extremities, whilst others are arcuate and much thicker in the middle. A few extremely slender needle-like forms are present. The surfaces are apparently all more or less spinulose. These appear to belong to the genus *Spongilla,* whilst a few smooth forms may belong to *Meyenia.* Very few traces of amphidiscs occur, but those seen are of the type of *Spongilla capewelli,* a species named by Bowerbank from specimens occurring at Lake Hindmarsh, Victoria.[10] A portion of what appears to be the head of a birotulate spicule, with a denticulate margin shows some resemblance to the form described by Prof. Haswell as *Meyenia ramsayi.*[11]

Regarding a similar diatomaceous and sponge spicular deposit, from the Warrumbungle Mountains, Mr. R. Etheridge (junr.)

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8. Kais. Leop.-Carol Deutsche Akad. Naturforscher, vol. LI., 1887.
9. Smithsonian Misc. Coll. vol. LXVII., No. 5, 1919 p. 233.
10. Proc. Zool. Soc. Lond., 1863, p. 447, pl. XXXVIII., fig. 3.
11. Proc. Linn. Soc. N.S. Wales, vol. VII., 1883, p. 210.

recognised in it[12] *Spongilla* sp., and this was confirmed by Dr. Hinde, who also determined the presence of amphidiscs, belonging the genus *Meyenia.*[13] The diatomaceous deposits of the Warrumbungle Mountains are, however, of greater age than those

Fig. 2 Spicules in Opal.

described above, for Prof. David has shown[14] that they are interbedded with a trachytic tuff, which has yielded leaves of *Cinnamomum Leichhardti,* Ett.

12. Ann. Rep. Dept. Mines, N.S. Wales for 1887 (1888), pp. 165, 166.
13. See Card and Dun, Rec. Geol. Surv. N.S. Wales, vol. V., 1897, p. 148.
14. Proc. Linn. Soc. N.S. Wales, vol. XXI., 1896, pt. 2, p. 265.

[Proc. Roy. Soc. Victoria 34 (N.S.), Pt. II., 1922].

Art. XVIII.—*On the Changes of Volume in a Mixture of Dry Seeds and Water.*

By ALFRED J. EWART, D.Sc., Ph.D. F.R.S.
(Professor of Botany and Plant Physiology in the University of Melbourne).

[Read 8th December, 1921].

If a quantity of dry peas is placed in a bottle filled with water, and provided with an open upright tube, it will be noticed that as the seeds swell the level of water in the tube rises, indicating a total increase of volume, and that after several hours the level of liquid in the tube falls again. The following observations illustrate this: The bottle used had a capacity of 1050 c.c., and 10 cms. of the erect tube contained 2.4 c.c. Peas were dried at 80°C., and the bottle two-thirds filled with them, and then filled up with water. The temperature of the peas was 20°C., and of the water 13.6. The increase or decrease of volume was measured from the height of liquid in the tube. The total

Temperature.	Time.	Total Increase or Decrease of Volume.
16·3°C.	12 a.m.	0·0c.c.
—	12.30 p.m.	+0·36 c.c.
16·3°C.	3 p.m.	+5·6c.c.
16·4°C.	3.50 p.m.	0·0c.c.
15·8°C.	10 p.m.	−18·7c.c.
13·8°C.	10 a.m.	−10·8c.c.

volume therefore first increases, then decreases by a still greater amount, and finally increases again. The final increase is apparent only, and is due to the production of small bubbles of gas by anaerobic respiration. It begins, however, before the bubbles actually appear.

This simple observation has long been known, and has been variously explained. It has even been stated to be a good way of demonstrating the expansion of seeds in water, ignoring the fact that the expansion of the seeds should be proportional to the amount of water they absorb, leaving the total volume unaltered.

The variation in the total volume might in fact be due to a variety of causes, and since seeds have specific structure, it need not follow the same course for all seeds. In regard to the first increase of total volume, this might be the result of the slight rise of temperature when dry seeds absorb water. Hence the experiment was repeated with the peas and water at the same original temperature (13.6°C.), the mixture being well stirred to remove any adhering air bubbles.

Temperature.	Time.	Total Increase or Decrease of Volume.
13·7°C. -	10 a.m. -	0·0c.c.
14·3°C. -	12.10 p.m. -	+6·9c.c.
14·8°C. -	3.20 p.m. -	+3·9c.c.

In this case a pronounced contraction of volume took place, while the temperature was still rising. The fact that the alterations of volume are far greater than any fluctuations due to changes of temperature can also be shown by direct estimation.

Using a bottle of 1050 c.c. capacity, with a tube attached, of which 10 cms.=2.4 c.c., the actual expansion of the water can be calculated from the formula—

$$v_t = v_o(1 + \alpha t)$$

where $\alpha = 15 \times 10^{-6}$ between 10°C. and 20°C.

The increases of volume per 1°C. at various temperatures are given.

		Estimated Increase of Volume.	Observed Rise in Tube.
Between	10–12°C. -	0·1056c.c.=0·44cms. -	
	12–14°C. -	0·1416c.c.=0·59cms.	
	14–16°C. -	0·1512c.c.=0·63cms. -	0·68cms.
	16–18°C. -	0·1824c.c.=0·76cms. -	0·82cms. (16–20°C.)
	18–20°C. -	0·1920c.c.=0·80cms. -	

In spite of the fact that the observed rise only gives the apparent expansion, it is greater than the theoretically calculated absolute expansion, but the methods used were not very refined, and were merely intended to show that the fluctuations of volume due to slight changes of temperature are small compared with those caused by the swelling seeds.

The increase of total volume with swelling peas is most pronounced when the seed coat has become markedly wrinkled, suggesting that the increase of volume is connected with wrinkling of the seed coat. This is easily proved by using split peas, in which case the total volume does not undergo any preliminary increase, but decreases from the outset until the final rise due to the production of gas. The first experiment was carried out with air-dry material, the second with material oven-dried at 80°C. The original total volume was 1050 c.c., and the receiver was two-thirds filled with the split peas. It will be seen that the contraction is much less with the air-dry material which already contained 16 per cent. of water.

Air Dry Split Peas.

Temperature.	Time.	Total Increase or Decrease of Volume.
11°C.	10 a.m.	0·0c.c.
11·5°C.	12.30 p.m.	−1·5c.c.
12·1°C.	11.30 p.m.	+0·77c.c.
Oven Dried Split Peas.		
13·7°C.	11 a.m.	0·0c.c.
15·6°C.	1 p.m.	−6·1c.c.
13·3°C.	10.30 p.m.	+0·53c.c.

Similar results were obtained with split lentils, the material being first washed with spirit, and then rapidly with water to remove adherent air bubbles.

Split Lentils Air Dried.

Temperature.	Time.	Total Increase or Decrease of Volume.
13·3°C.	10.50 a.m.	0·0c.c.
13·8°C.	2.30 p.m.	−3·55c.c.
14·3°C.	6 p.m.	−3·15c.c.
Split Lentils Dried at 80° C.		
13·4°C.	11.55 a.m.	0·0c.c.
13·4°C.	7.40 p.m.	−6·5c.c.
13·3°C.	5 a.m.	−5·66c.c.

The observations were discontinued as soon as a distinct increase of volume begins, for this is merely due to the appearance of gas bubbles, and proceeds rapidly once it has commenced.

Since the first increase of total volume shown with whole peas is due to the wrinkling of the seed coat, the suggestion may be made that the wrinkles are due to local regions of the skin absorbing water, and expanding more rapidly than others. This would result in a tendency to a partial vacuum beneath each wrinkle, and this would hasten the drawing in of water, and at the same time increase the total volume of the mixture of seeds and water. If this were so, then under pressure the first expansion should be either greatly decreased or suppressed.

For this purpose a stout separating funnel was used. Peas and water were introduced at the top, which was then sealed. To the lower end a long-armed U tube was attached. This contained a water column continuous with that in the funnel. Mercury was then poured into the open arm of the U tube until the difference of level was 76 cms. After each reading the mercury was brought up to the original level if contraction had taken place, or reduced to the same level with the aid of a pipette if expansion had occurred. The temperature varied within 1°C. during the experiment, a maximum rise of 1°C. being shown after three hours, when the total volume had begun to decrease. The total initial volume was 1080 c.c. and a two-thirds charge of oven-dried peas was used.

Time.	Total Increase or Decrease of Volume.	
3 p.m.	[0·0c.c.]	0·0c.c.
3.35 p.m.	[+2·3c.c.]	−0·10c.c.
4 p.m.	[+4·7c.c.]	+0·28c.c.*
4.40 p.m.	[+6·3c.c.]	+0·76c.c.
5 p.m.	[+2·1c.c.]	0·0c.c.
8 p.m.	[−2·4c.c.]	−2·0c.c.
9 p.m.	[−3·0c.c.]	−4·8c.c.
9 a.m.	[−1·1c.c.]*	−5·6c.c.†
10 a.m.	—	−5·6c.c.

* Seeds beginning to wrinkle.
† Seeds fully swollen.

Owing to the pressure the final expansion due to the liberation of gas bubbles is long delayed. The figures in brackets give the expansion and contractions of a similar volume of peas and water not under pressure. At * gas production began preventing the full contraction of volume.

It will be noticed that under pressure there is a slight contraction of volume before the expansion due to the wrinkling of the seed coat begins. This is probably the result of the pressure on air in the intercellular spaces of the cotyledons. These are not entirely obliterated on drying, as can be seen by examining sections of dry peas in pure glycerine. A large receiver with a manometer attached showed an unchanged pressure of –76 cms. for an hour after exhaustion with a double Geryck pump. It was then filled with dry peas, and again rapidly exhausted. The exhaustion required a few more strokes, and on standing for an hour the pressure increased from –76 cms. to –72 cms., then remaining stationary. This shows that the dry peas do actually contain a little air.

In the case of all seeds in which the seed coat wrinkles more or less during absorption, the total volume shows a preliminary increase, followed by a decrease, as in the case of peas, and a final increase of volume, which is only apparent, and is due to the production of gas. It usually begins before any actual gas appears, but is then due to gas forming in the intercellular spaces of the seed, and driving out some of the water contained in them.

Tick (Horse) Beans. Total Volume 1065 cc. $\frac{2}{3}$ Charge of Beans.

Temperature.	Time.	Total Increase or Decrease of Volume.
11·4°C.	10.40 a.m.	0·0c.c.
12·2°C.	5 p.m.	+9·98c.c.
12·5°C.	7.30 p.m.	+9·28c.c.
11·7°C.	10.15 a.m.	–2·54c.c.
12·0°C.	10 p.m.	–4·39c.c.
11·6°C.	10 a.m.	+2·5c.c.

Haricot Beans. Total Volume 1055 cc. $\frac{2}{3}$ Charge of Beans.

Temperature.	Time.	Total Increase or Decrease of Volume.
12·5°C.	3 p.m.	0·0c.c.
12·65°C.	3.40 p.m.	+2·5c.c.
13·3°C.	7.45 p.m.	–4·6c.c.
11·8°C.	10 a.m.	–10·08c.c.
12·6°C.	5.15 p.m.	–14·6c.c.
12·6°C.	7 p.m.	–11·2c.c.*

* No bubbles of gas as yet formed.

In the case of barley and cereal grains in which the integuments do not wrinkle while absorbing water, the total volume contracts from the commencement until the rise due to gas production begins.

The following tests give the contractions obtained with air-dried and oven-dried barley. The total volume was 1056 and

1060 c.c. respectively. The receiver was two-thirds filled with barley, after this had been rapidly washed with spirit to remove air, and with water to remove light grain.

BARLEY (AIR DRIED).

Temperature.	Time.	Total Contraction.
13·8°C.	zero	0·0c.c.
13·5°C.	24 hours	—2·38c.c.
BARLEY (OVEN DRIED).		
12·4°C.	zero	0·0c.c.
12·4°C.	6 hours	—3·02c.c.

It is of interest to compare these contractions with those of agar and gelatine when swelling in water. Ordinary flake or strip agar or leaf gelatine cannot be used, as it is impossible to obtain a mixture with water free from air, and they swell too rapidly. Nelson's strip gelatine gave good results, and granulated agar was used, the granules swelling to the size of kidney beans or broad beans in water. In both cases a rise of temperature of 0.5 to 1°C. takes place, but the final readings were taken when the temperature had fallen approximately to the calorimeter level again. The contraction of volume is small, and it takes place almost wholly in the first hour with the gelatine, and in the first seven hours with the agar, i.e., long before either are fully swollen.

GELATINE. 150 GRAMS. TOTAL VOLUME, 1050 CC.

Temperature.	Time.	Contraction of Volume.
15·5°C.	zero	0·0c.c.
15·5°C.	70 minutes	0·912c.c.
AGAR. 50 GRAMS. TOTAL VOLUME, 1056 CC.		
15·2°C.	zero	0·0c.c.
15·1°C.	7 hours	0·65c.c.

At a temperature of 15°C., 1000 c.c. of water would undergo a decrease of volume of 0.495 c.c. under an increased pressure of 10 atmospheres. Hence a decrease of 0.912 c.c. indicates an increased pressure of 20 atmospheres. This is exercised on the water by the gelatine in the process of swelling. The pressure is probably much greater than this at first, and lessens as the gelatine swells throughout, but on the other hand, more water is under compression. The maximal total contraction will be given at some intermediate point between commencing absorption and complete absorption and swelling.

There may be two reasons for the greater contraction of volume with swelling seeds as compared with the gelatine. Using equal volumes of barley, haricot beans and peas, the maximal contraction obtained varied from 2.5 to 6 c.c., but in all cases were greater than with gelatine. This would indicate absorption pressures of 50 to 120 atmospheres. An organised colloid, like cellulose, may be capable of showing a higher absorption pressure than an unorganised one like gelatine. In addition a certain amount of solution may take place in the seed as water is absorbed. Tamman[1] has shown that a volume of a solution under one atmosphere pressure expands when heated like a similar volume of water under a constantly higher pressure, i.e., a solution has a high internal pressure due to the solute. This action is a general one, independently of whether the solute is an electrolyte or a non-electrolyte. In other words, the minimum volume temperature of water is lowered by the presence of a solute. It follows, therefore, that as some of the food constituents of the seed begin to dissolve, the total volume may tend to undergo a slight decrease as the result of the action of the solute. There are, however, certain exceptions to this rule. For instance, a mixture of ammonium chloride and water expands on solution, so that a 6.85 per cent. solution has an increased volume of 0.266 c.c. (100.266 c.c. instead of 100 c.c.).[2] Hence it is impossible to say exactly what part may be played by dissolving solids in producing a contraction of the total volume.

In addition, if cellulose obtained from a colloidal solution has the same composition as that in the cell-wall, the fact that it has a higher density may indicate that in penetrating the cell-wall the water molecules may partly enter empty intermicellar spaces, thus producing a contraction of total volume. It is at least evident that the changes of volume in a mixture of dry seeds and water are by no means simple phenomena, but are due to various interacting, and in some cases antagonistic factors.

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1 G. Tamman, Ueber die Beziehungen Zwischen den inneren Kräften and Eigenshaften der Lösungen, Voss, Hamburg and Leipzig, 1907.

2 Happart, Bulletin Inst. Liege, 1903.

Summary.

Marked changes of the total volume are shown when dry seeds absorb water.

If the seed coat wrinkles, there is first an expansion, then a contraction, and then a final rise which is due to the production of gas in the seed. The changes are not the result of alterations of temperature. The wrinkling is due to unequally rapid absorption, partial vacuums forming under the wrinkles, which hasten the indrawal of water. If the seed coat does not wrinkle there is no preliminary expansion, and the contraction is due as in gelatine to the compression of the absorbed water.

Using similar methods as with the seeds, the contraction obtained with gelatine indicated a pressure of 20 atmospheres, but with seeds as much as 50 to 120 atmospheres pressure was indicated. This may be due partly to the greater imbibition pressure of organised cellulose as compared with gelatine, and partly to the influence of solutes increasing the internal pressure of the water within the seeds.

[PROC. ROY. SOC. VICTORIA 34 (N.S.), PT. II., 1922.]

ART. XIX.—*Further Researches into the Serological Diagnosis of Contagious Pleuro-Pneumonia of Cattle.**

BY G. G. HESLOP, D.S.O., D.V.Sc., D.V.H.
(Walter and Eliza Hall Fellow).

(Communicated by Professor H. A. Woodruff.)

[Read 18th December, 1921.]

Introduction.

In a former publication by the writer on the Serological Diagnosis of Contagious Pleuro-pneumonia of Cattle (1),[1] a description was given of research work carried out at the Veterinary Research Institute, Melbourne University, under the terms of the Walter and Eliza Hall Research Fellowship in Veterinary Science. The main object of the research was to endeavour to elaborate a sero-diagnostic method for the detection of Contagious Pleuro-pneumonia in affected cattle.

Agglutination tests, using both the macroscopic and microscopic methods of testing for agglutinins, were tried, but failed to reveal the presence of agglutinins in the sera of animals *naturally* affected with contagious pleuro-pneumonia.

Agglutinins however were demonstrated macroscopically in the serum of an experimental animal (calf) which had been injected subcutaneously in the tail with active pleuro-pneumonia virus, and which subsequently received two further injections subcutaneously behind the shoulders at intervals of 10 to 12 days; one injection being of pleuro-pneumonia virus, the other of pure culture.[2] Agglutination tests, using the microscopic method with dark ground illumination, were not carried out, and it has been considered desirable to carry out further examinations of culture and various test sera under the microscope with dark ground illumination so as to determine whether, by using that method, the presence of agglutinins could be detected in the sera of naturally affected cattle.

(* Being the Final contribution in a Thesis approved for the degree of Doctor of Veterinary Science in the University of Melbourne.)

1. Reference is made by number to "Literature Cited," p. 195.
2. Loc. cit., p. 177.

Complement fixation tests were carried out, and a description was given of a complement fixation test which has been applied for the diagnosis of contagious pleuro-pneumonia in cattle. The technique of this test, however, is considered to be too intricate and laborious to allow of its adoption as a routine diagnostic method. Further, it was found that the test was only approximately accurate in its results, for, on testing the sera of 63 different animals (cattle) a positive result was obtained with the serum of one animal which, on subsequent post-mortem examination, showed no lesions of contagious pleuro-pneumonia in the lungs. Two other animals gave reactions which could not be definitely interpreted either as negative or positive. On submitting these two animals to post mortem examination, no lesions of contagious pleuro-pneumonia were discovered.

The results of the tests of these 63 serum samples can be conveniently tabulated as follow:—

Number of serum samples tested—63	
Gave positive reaction to test and showed lesions of C.P.P. on P.M.	13
Gave positive reaction to test and showed no lesions of C.P.P. on P.M.	1
Gave negative reaction to test and showed lesions of C.P.P. on P.M.	0
Gave negative reaction to test and showed no lesions of C.P.P. on P.M.	47
Gave border line reaction to test and showed lesions of C.P.P. on P.M.	0
Gave border line reaction to test and showed no lesions of C.P.P. on P.M.	2

At first sight this tabulation appears to show that the test has been fairly accurate in differentiating between animals which were and which were not affected with contagious pleuro-pneumonia, but if the figures are analysed carefully, it is found that the percentage of error is an unduly large one. Sixty-three serum samples were tested, and of the reactions obtained, 60 were verified by the post-mortem findings, while the other three were not. In a total of 50 negative sera tested, 47 reacted negatively, and three gave reactions which were not negative, an error of 6 per cent. Fourteen serum samples gave positive reactions; 13 of these were verified by the post-mortem findings, one was not; an error of approximately 7.14 per cent. If we add to these

14 positive reactions the two "doubtful" reacting sera, we have a total error of three in 16, or 18.75 per cent., which is a very high percentage of error in a diagnostic test.

As it could not be claimed that the complement fixation test described was sufficiently accurate to warrant its general application as a diagnostic method for contagious pleuro-pneumonia, further research work was considered desirable in order to ascertain—

1. Whether the test could be rendered more accurate in its results.
2. Whether the technique for the test could be simplified without reducing the accuracy of the reaction.
3. Whether certain extracts of tissue and of culture possessed greater value as antigens for the test than the antigen previously used.

The present paper deals with this further research work which has been carried out in the laboratories of the Veterinary Research Institute during the current year. I desire to express my grateful appreciation and thanks to Dr. S. S. Cameron, Director of Agriculture, Victoria; Professor H. A. Woodruff, Director of the Veterinary Research Institute, Melbourne University; W. A. N. Robertson, Esq., B.V.Sc., Chief Veterinary Officer, Department of Agriculture, Victoria; Dr. L. B. Bull, Deputy Director South Australian Laboratory of Pathology and Bacteriology; Dr. W. J. Penfold, Director of the Commonwealth Serum Laboratories; and the Staff of the Live Stock Division, Department of Agriculture, Victoria, for the assistance they have rendered me during the course of this research.

Fermentation Reactions of the Organism of Contagious Pleuro-Pneumonia.

With reference to the fermentation reactions of the organism of contagious pleuro-pneumonia, previous work had shown that the organism would grow in Martin's broth plus ox serum to which either saccharose, glucose, maltose, or lactose had been added, but would not grow in similar media to which the alcohol derivatives mannite and dulcite had been added.[3] As the mannite and dulcite used was laboratory stock several years old it was decided to repeat the experiment, using new samples of mannite and dulcite.

3. Loc. cit., p. 170.

Experiments have accordingly been made with mannite and dulcite (Gurr), using adequate controls, and it has been found that growth of the organism occurs in both mannite and dulcite Martin's broth, but no acid or gas is developed in the medium as a result of the growth which takes place. Andrade's indicator has been used as the indicator for the experiments. The mannite and dulcite were added to the broth media in the proportion of 2 per cent. in each case. Growth was apparent in from four to five days after incubation at 37°C.

The fermentation reactions of the organism of contagious pleuro-pneumonia are therefore as follow:—

	Saccharose	Glucose	Maltose	Lactose	Mannite	Dulcite
Acid	–	++	+	–	–	–
Gas	–	–	–	–	–	–

Growth takes place with each reagent.

+ = Acid. ++ = Strongly acid. – = No reaction.

Complement Fixation.

Attempts have been made to simplify the technique for the complement fixation test, but it has been found that with each attempted modification of the technique already laid down further inaccuracies have occurred in the results. As a result of the further experiments carried out it is now apparent that the best results with the complement fixation test are obtained when the technique set out in detail in the writer's previous article is carefully followed.

Various new preparations have been tested as antigens for the complement fixation test. Certain of the preparations tested have shown some ability to fix complement in the presence of a positive serum, while with others no visible fixation of complement has occurred at all. In all cases the new preparations tested have been proved to be inferior in antigenic value to the alcoholic extract of subepidermal tumour tissue used in the experiments reported fully in the writer's previous article.

The new preparations tested as antigens were as follow:—

Antigen 1.—An alcoholic extract of the dried residue after rapid evaporation of a seven days' old culture of the organism of contagious pleuro-pneumonia in Martin's broth ox serum. On testing, this extract was found to possess no demonstrable antigenic value.

Antigen 2.—An alcoholic extract of three months' old culture of the organism of contagious pleuro-pneumonia in Martin's broth horse serum. On testing, this extract was found to possess no demonstrable antigenic value.

Antigen 3.—An alcoholic extract of normal ox heart muscle. On testing, this extract was found to possess no demonstrable antigenic value.

Antigen *4.*—An alcoholic extract of guinea-pig's heart muscle. On testing, this extract was found to possess only slight antigenic value. No fixation of complement occurred with known negative sera, while, with known positive sera, in three out of ten samples tested there was slight inhibition of haemolysis. The remaining seven positive samples gave negative reactions.

Antigen 5.—An alcoholic extract of diseased lung taken from an active case of contagious pleuro-pneumonia. On testing, this extract was found to possess no demonstrable antigenic value.

Antigen 6.—An alcoholic extract of fresh sub-epidermal tumour tissue removed from behind the shoulder of calf 10 after an experimental subcutaneous inoculation of pure virus in that region. On testing, this extract was found to possess a fairly high antigenic value. No fixation of complement occurred when it was tested with 10 different samples of known negative sera, while with 10 different samples of known positive sera, nine showed fixation of complement varying from partial to complete fixation, the other known positive serum reacted negatively. This extract was unsatisfactory in that it was highly anti-complementary in any quantity tested of a 1 in 10 dilution with saline. Even in a 1 in 20 dilution it was anticomplementary excepting in the smallest amounts. 0.05 c.c. of 1 in 20 dilution was the unit used for the tests already referred to.

Antigen 7.—An alcoholic extract of the dried residue of evaporated culture (Antigen 1), to which was added 0.4 per cent. chlosterin.

Antigen 8.—An alcoholic extract of three months' old culture in Martin's broth horse serum (Antigen 2) to which was added 0.4 per cent. chlosterin.

Antigen 9.—An alcoholic extract of ox heart muscle (Antigen 3) to which was added 0.4 per cent. chlosterin.

Antigen 10.—An alcoholic extract of guinea-pig's heart muscle (Antigen 4) to which was added 0.4 per cent. chlosterin.

Antigen 11.—An alcoholic extract of fresh subepidermal tumour tissue from experimental Calf 10 (Antigen 6) to which was added 0.4 per cent. chlosterin.

Antigen 12.—An alcoholic extract of dried subepidermal tumour tissue from Calf 10, to which was added 0.4 per cent. chlosterin.

The chlosterin used in the preparation of Antigens 7, 8, 9, 10, 11 and 12 was a sample freshly prepared in the Physiological laboratories of the Melbourne University. The extracts to which chlosterin was added were found to be so highly anticomplementary that they were useless for testing purposes. Antigens 11 and 12 were again made up, but with only half the quantity of chlosterin added, i.e., 0.2 per cent. They were found on testing to be still too anticomplementary for use in a complement fixation test.

Agglutination Tests.

A number of blood samples were obtained from animals which were found to be infected with contagious pleuro-pneumonia at the time of slaughter and post-mortem examination. Blood samples were also obtained from a number of animals who were known not to be affected, or to have been in contact with the disease. In this manner a large number of "known positive" and "known negative" serum samples have been acquired, and these sera have been used as test sera in the agglutination tests.

Microscopic Agglutination.

Agglutination tests with known positive and known negative sera, using the microscopic method with dark ground illumination, have been carried out with very unsatisfactory results. With a known positive serum, agglutination can be observed invariably in a dilution of 1 in 20 in about three and a-half hours after mixing. Unfortunately, however, the majority of known negative sera tested also showed agglutination in the same dilution in the same time. In dilutions of 1 in 30, only five out of eight positive sera tested showed agglutination, while two out of 8 negative sera tested also showed agglutination in the same dilution. In dilutions of 1 in 35, two positive sera out of eight tested showed agglutination, while none of the eight negative sera tested showed agglutination in that dilution. No serum, either positive or negative, showed agglutination in a dilution of 1 in 40.

It is worthy of note that the positive sera which showed agglutination in three and a-half hours in dilutions of 1 in 30, and 1 in 35, were sera taken from animals affected with the disease in an acute form.

The results of agglutination tests under the microscope with dark ground illumination can be conveniently tabulated as follow:—

Dilutions.

NUMBER OF CASES SHOWING AGGLUTINATION IN ANY DEGREE.

	1 in 5	1 in 10	1 in 15	1 in 20	1 in 25	1 in 30	1 in 35	1 in 40
Known positive sera (total tested = 8)	8	8	8	8	7	5	2	0
Known negative sera (total tested = 8)	8	8	7	6	3	2	0	0

No recognisable agglutination takes place under the microscope at room temperature until at least one hour after the mixture of culture and serum has been made. The agglutination is apparently completed in approximately three and a-half hours after mixing, and the results tabulated above were obtained from readings made three and a-half hours after the mixture of culture and serum had been made.

The cultures used in these tests had been grown in Martin's broth ox serum (Reaction PH=8.4 approximately), and subcultured every seven to eight days until the eighteenth to twentieth subculture stages had been reached. Each subculture at the time it was used in a test was from six to eight days old.

A live culture was used in each case.

There is a considerable amount of technical difficulty in the conduct of microscopic agglutination tests in which dark ground illumination is an essential factor. The fact that the organism of contagious pleuro-pneumonia is of such minute size adds to the difficulty of successfully carrying out such tests.

Altogether the results of these microscopic agglutination tests are disappointing in that they do not offer a solution of the problem of diagnosing the disease in the living animal. They are of very great interest, however, in that they furnish the first instance in which agglutinins have been demonstrated to occur in the sera of animals *naturally* infected with contagious pleuro-pneumonia.

Macroscopic Agglutination.

The results of a considerable amount of work on the macroscopic agglutination test for contagious pleuro-pneumonia have already been published by the writer, who was able to demonstrate the presence of agglutinins in the serum of a hyper-immunised calf (Calf 1), but could not demonstrate them in the sera of animals infected with contagious pleuro-pneumonia naturally acquired. Calf 1 had reacted to a primary subcutaneous inoculation of active pleuro-pneumonia virus in the tail, and subsequently received two further subcutaneous inoculations of virulent material (one of active pleuro-pneumonia virus, the other of pure culture) behind the shoulders at intervals of 10 to 12 days. Serum from Calf 1 in dilutions up to 1 in 70 caused macroscopic agglutination of a culture of the organism of contagious pleuro-pneumonia, while the sera of non-immunised animals used as controls had no agglutining effect upon a similar quantity of the same culture.[4]

The presence of agglutinins in the sera of hyper-immunised bovines has been confirmed by Titze and Seelemann, (2) who have recently published the results of their experiments in which they were able to demonstrate the presence of specific agglutinins in the serum of a hyper-immunised heifer and of a hyper-immunised bull.

While specific agglutinins can be demonstrated in the sera of hyper-immunised cattle, all attempts by the writer to demonstrate the presence of agglutinins in the sera of animals naturally infected with contagious pleuro-pneumonia have, until recently, been unsuccessful; the conclusion arrived at by the writer in his previous publication being as follows:—

"Agglutinins could not be demonstrated, in the sera taken from bovines known to be affected with contagious pleuro-pneumonia, by the usual macroscopic and microscopic methods of testing for agglutinins. Therefore an agglutination test apparently has no value as a means of differentiating between animals which are, and which are not, affected with the disease."[5]

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4. Loc. cit., p. 183.
5. Loc. cit., p. 209.

This conclusion has now to be considerably modified and amended when viewed in the light of the results obtained in the further experiments carried out during the present year.

If a first or second subculture of the organism of contagious pleuro-pneumonia is used in an agglutination test with the serum of an animal known to be affected with contagious pleuro-pneumonia, agglutination of the culture cannot be observed macroscopically at any time up to 40 hours after mixing the culture and serum together. This fact has been repeatedly established by experiments conducted by the writer, and it was upon the results of those experiments that the above quoted conclusion was arrived at. Further experimentation has demonstrated, however, that agglutination of a culture of the organism of contagious pleuro-pneumonia by such a serum will occur, provided the culture used is *an old laboratory strain which has been subjected to repeated cultivation through several generations of subcultures,* the subcultures being made at intervals of from six to eight days.

If, for instance, an eighteenth or twentieth subculture, six to eight days old, is taken, and to it is added various dilutions of a known *positive* serum, agglutination and sedimentation of the culture will occur, and the supernatent fluid will lose its opalescence and become clear. In the lower dilutions agglutination can also be observed with the same culture and a known *negative* serum, but, while agglutination takes place with a known positive serum in a dilution as high as 1 in 400, which dilution contains only 0.005 c.c. of pure serum, no dilution of a known negative serum higher than 1 in 80, which dilution contains 0.025 c.c. of pure serum, has been found capable of producing agglutination of the same amount of culture. Thus there is a considerable difference in the end point values of positive and negative sera respectively, the difference being sufficiently great to preclude any possibility of errors in reading and recording the results of the reactions.

The agglutination reaction in contagious pleuro-pneumonia *proceeds slowly* at incubator temperature, and apparently it is complete only after 48 hours in the incubator at 37°C. After 24 hours' incubation little, if any, agglutination is apparent with any dilution from 1 in 20 upwards of a known positive serum taken from an acute case of contagious pleuro-pneumonia, whereas after 48 hours, marked agglutination can usually be observed in a dilution of 1 in 400 or even higher.

Attempts to expedite the reaction by heating the tubes in a water bath at various temperatures between 45°C. and 55°C. have not been successful, and the reactions obtained after incubation at such temperatures have not been so satisfactory, even at the end of 48 hours, as the reactions obtained with the same sera heated at 37°C. Incubation for 48 hours at room temperature does not give as satisfactory results as incubation for 48 hours at 37°C.

To prevent the growth of contaminating micro-organisms in the tubes during the 48 hours' incubation period required for the test, carbol saline solution was used as the diluting fluid. This solution, which consists of 0.5 per cent. carbolic acid in 0.9 per cent. saline solution, has been found to be effective for the purpose intended, while at the same time it does not appear to exert any unfavourable action in the test.

The cultures used in these macroscopic agglutination tests were cultures of the organism of contagious pleuro-pneumonia, grown in Martin's broth ox serum.[6] (Reaction PH=8.4 approximately), and subcultured every 7-8 days, until at least the eighteenth subculture stage had been reached. Each subculture at the time it was used in a test was from six to eight days old. In each test the culture used was a live culture which showed a uniform though faint opalescence.

One c.c. of culture (which quantity was taken as the standard amount) was measured into each of a series of agglutination tubes. To each tube there was added a graded quantity of serum diluted with carbol saline so that the combined amounts of serum and carbol saline in each tube was equal to the amount of culture contained in the same tube. Each tube therefore contained 2 c.c.s. of fluid.

In this manner, serum dilutions of 1 in 20, 1 in 40, 1 in 80, 1 in 100, 1 in 133, 1 in 200, and 1 in 400 were prepared and tested.

The following table will explain the method of setting up the test:—

Tube.	Culture.	Saline.	Serum.	Contents.	Dilution.
1	1c.c.	·9	·1	2c.c.	1 in 20
2	1c.c.	·95	·05	2c.c.	1 in 40
3	1c.c.	·975	·025	2c.c.	1 in 80
4	1c.c.	·98	·02	2c.c.	1 in 100
5	1c.c.	·985	·015	2c.c.	1 in 133
6	1c.c.	·99	·01	2c.c.	1 in 200
7	1c.c.	·995	·005	2c.c.	1 in 400
*8	—	1·9	·1	2c.c.	—
*9	1c.c.	1c.c.	—	2c.c.	—

6. Martin's peptone broth to which has been added 7.5 per cent. fresh unheated ox serum sterilised by filtration.
* Controls.

Twenty-three different sera obtained from animals affected with pulmonary lesions of contagious pleuro-pneumonia, the presence of the disease being verified by post-mortem examination at the time that the blood samples were taken, have been submitted to agglutination tests set up in the above manner, and in each instance marked agglutination has been the result.

On comparing the results of the agglutination tests of these 23 positive sera with the post-mortem findings of the animals supplying them, it has been found that the more acute cases of contagious pleuro-pneumonia yield a serum which has a higher agglutination titre than that from cases in which the disease has become chronic and where encapsulation of the lung lesion has taken place more or less completely. Even in these latter chronic cases, in no instance in this series of tests had there been failure to produce agglutination in dilutions of 1 in 133. In the more acute cases, with one exception, agglutination occurred in dilutions of 1 in 400, while in two such cases agglutination occurred in dilutions of 1 in 750. The one exception referred to above was Number 143, the serum of an animal affected with the disease in an acute form, but which serum had a final agglutination titre of 1 in 133 only. It would therefore appear that a serum with a high agglutination titre points to an acute infection, but, in view of the one exception quoted above this cannot be stated as an invariable fact, but only as a general rule.

In addition to the agglutination tests of 23 different known positive sera, tests have been made with 18 different sera obtained from animals which were found on post-mortem examination to be free from lesions of contagious pleuro-pneumonia. These known negative sera all showed agglutination in dilutions of 1 in 20. Thirteen of them showed agglutination in dilutions of 1 in 40, while five of them showed slight agglutination in dilutions of 1 in 80. None of them showed any recognisable agglutination in dilutions of 1 in 100.

A complete list of the sera tested and a table of the reactions obtained with each is appended, together with an indication of the post mortem findings on slaughter of the animals supplying the test sera.

TUBE.

Serum Number.	1	2	3	4	5	6	7	8	9	Animal Supplying Serum Showed on Post-mortem.
105	+++	+++	++	++	++	++	+	No change	No change	Acute infection
106	++	++	++	++	++	++	++	,,	,,	Acute infection
107	+	++	+++	++	++	++	++	,,	,,	Acute infection
108	++	++	++	++	++	+	S	,,	,,	Acute infection
109	++	+	—	—	—	—	—	,,	,,	No lesions
110	+	S	—	—	—	—	—	,,	,,	No lesions
111	++	+	S	—	—	—	—	,,	,,	No lesions
112	++	++	+	+	+	S	—	,,	,,	Chronic infection
113	++	+	—	—	—	—	—	,,	,,	No lesions
114	+	S	—	—	—	—	—	,,	,,	No lesions
115	++	++	++	+	+	+	S	,,	,,	Acute infection
116	++	++	+	+	S	S	—	,,	,,	Chronic infection
117	S	—	—	—	—	—	—	,,	,,	No lesions
118	++	+	+	+	+	+	+	,,	,,	Acute infection
119	++	++	++	++	++	++	++	,,	,,	Acute infection
120	+	+	++	++	+	+	S	,,	,,	Acute infection
121	+	S	—	—	—	—	—	,,	,,	No lesions
122	++	++	+	—	—	—	—	,,	,,	No lesions
123	+	S	—	—	—	—	—	,,	,,	No lesions
124	S	—	—	—	—	—	—	,,	,,	No lesions
125	S	—	—	—	—	—	—	,,	,,	No lesions
126	+	S	—	—	—	—	—	,,	,,	No lesions

+++ = Agglutination and sedimentation of agglutinated organisms with complete naked eye clearing of the supernatent fluid.
++ = Agglutination with well defined deposit, fluid nearly clear.
+ = Marked flocculent agglutination and some sedimentation, fluid not clear.
S = Slight aggultination deposit, fluid not clear.
— = No naked eye trace of agglutination or clearing of fluid.

TUBE.

Serum Number.	1	2	3	4	5	6	7	8	9	Animal Supplying Serum Showed on Post-mortem.
127	++	++	++	++	+	+	+	No change	No change	Acute infection
128	+++	+++	+++	+++	++	++	++	,,	,,	Acute infection
129	++	++	++	++	++	+	+	,,	,,	Acute infection
130	++	++	+	+	+	S	—	,,	,,	Chronic infection
131	++	++	++	++	++	++	++	,,	,,	Acute infection
132	+++	+++	+++	+++	+++	+++	++	,,	,,	Acute infection
133	++	++	++	+	+	S	S	,,	,,	Acute infection
134	++	+	S	—	—	—	—	,,	,,	No lesions
135	S	—	—	—	—	—	—	,,	,,	No lesions
136	++	++	++	++	++	++	++	,,	,,	Acute infection
137	++	++	++	+	+	S	—	,,	,,	Chronic infection
138	++	++	++	++	+	+	+	,,	,,	Chronic infection
139	+++	+++	++	++	++	++	++	,,	,,	Acute infection
140	+	—	—	—	—	—	—	,,	,,	No lesions
141	++	+	S	—	—	—	—	,,	,,	No lesions
142	+	S	—	—	—	—	—	,,	,,	No lesions
143	++	++	++	++	+	—	—	,,	,,	Acute infection
144	+	S	S	—	—	—	—	,,	,,	No lesions
145	++	++	++	++	++	++	+	,,	,,	Acute infection

+++ = Agglutination and sedimentation of agglutinated organisms with complete naked eye clearing of the supernatent fluid.
++ = Agglutination with well defined deposit, fluid nearly clear.
+ = Marked flocculent agglutination and some sedimentation, fluid not clear.
S = Slight agglutination deposit, fluid not clear.
— = No naked eye trace of agglutination or clearing of fluid.

Compared with the complement fixation test in contagious pleuro-pneumonia, the agglutination test appears to possess a reliability and accuracy in reaction which is at least equal to, if not greater, than that of complement fixation.

Agglutination reactions are not affected by the presence of conglutinin in bovine sera, whereas that same substance is always liable to affect the result of complement fixation reactions, and may be responsible for a large number of false reactions.

To prevent the action of conglutinin interfering with the accuracy of the complement fixation test, an exceedingly intricate and laborious technique has to be followed in each detail by the operator. In these successive manipulations the possibility of personal error on the part of the operator is very largely increased. By reason of its simpler technique the agglutination test is not so liable to errors on the part of the worker.

So far as it has been tested, the agglutination reaction in contagious pleuro-pneumonia appears to provide us with a simple means for determining the presence of the disease, at least in the acute form, in the living animal. Although the number of positive sera tested is not very large, being only 18 from animals in which the disease was acute, and five from animals in which the disease was chronic, it would appear that the possibility of error in acute cases of the disease is not very great owing to the well marked differences in the end point values of sera taken from acute cases, and those taken from animals free from the disease. In the case of animals in which the disease is chronic, diagnosis by means of the agglutination test does not appear to be so certain, although there is still a fairly wide difference in the end point values of such sera when compared with the values of known negative sera.

Application of the test to a large number of cases showing chronic lesions is necessary to justify any firm conclusions on this point.

Specificity of the Complement Fixation and Agglutination Reactions in Contagious Pleuro-Pneumonia.

Since the publication of the results of the examination of 63 different serum samples for complement fixation and the subsequent post-mortem findings when the animals were slaughtered, experiments have been conducted to ascertain whether, when a positive complement fixation result is obtained, the reaction has been induced solely by the fact that the animal is affected with contagious pleuro-pneumonia. In one of the cases quoted a positive complement fixation result was obtained, but no lesions of the disease could be discovered in the lungs when the animal supplying the test serum was subsequently submitted to a post-mortem examination. That the reaction might be *a group reaction for filterable viruses in general,* and not absolutely specific for the filterable virus causing contagious pleuro-pneumonia in cattle seemed possible. Of the diseases in cattle due to filterable viruses, only two, e.g., contagious pleuro-pneumonia and cow pox (Variola) are present in Australia, so that tests for comparative purposes have of necessity been confined to tests of sera from animals known to be affected with cow pox.

Samples of sera taken from a cow at the Veterinary School which was affected with extensive cow pox vesicles and pustules on the mammary gland, were tested and were found to give positive complement fixation results with the contagious pleuro-pneumonia antigen. The possibility of the same animal being affected with contagious pleuro-pneumonia as well as with cow pox was negatived by the general appearance of the animal and her previous history.

Through the courtesy of Dr. W. J. Penfold, Director of the Commonwealth Serum Laboratories, I have been able to obtain serum samples from 11 calves, which had been vaccinated with the virus of cow pox in the manufacture of vaccine lymph for human vaccination. Each of the calves had given a typical reaction to the vaccination.

On submitting the samples to complement fixation tests with the contagious pleuro-pneumonia antigen, it has been found that they all show some ability to inhibit haemolysis.

It is apparent therefore, that in carrying out tests with sera from an unknown source, the serum of an animal affected only with cow pox may cause sufficient inhibition of haemolysis in a complement fixation test for contagious pleuro-pneumonia to give rise to the assumption on the part of the person carrying out the test that the animal supplying the test serum is affected with contagious pleuro-pneumonia.

Serum from the cow affected with cow pox at the Veterinary School, which serum gave a positive complement fixation reaction, and the three samples of calf serum, which showed the greatest amount of inhibition of haemolysis in the complement fixation test, were next submitted to the macroscopic agglutination test. They are numbers 111, 121, 122, and 123 respectively in the chart of agglutination reactions forming portion of this paper. Their reactions to the agglutination test were negative in each case, although with numbers 111 and 122, agglutination took place in dilutions as high as 1 in 80.

Literature Cited.

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Art. XX.—*High Frequency Spectra—K Series of Platinum.*

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(With Text Figs. 1a, 1b, and 2.)

[Read 8th December, 1921.]

Introduction.

The purpose of this paper is to describe a precise method of measuring the wave lengths of the high frequency spectrum of platinum.

The method employed is one in which a rotating crystal spectrometer is used, and the platinum lines, together with those of tungsten, are recorded on the same film. The wave lengths of the platinum lines are deduced by inter- and extra-polation from the tungsten lines, the wave lengths of which are known with great accuracy, having been measured recently with great precision by Siegbahn,[1] and by Duane and Stenstrom.[2]

The investigation of the K lines of platinum, in common with those of other heavy elements, is beset with certain difficulties, which have prevented the spectra of these elements being determined.

In order to excite efficiently the K spectrum of an element of high atomic number, it is necessary to use the substance as target in an X-ray tube. A very high potential difference must then be applied to the tube, since a minimum pressure of 78,000. volt is required to obtain the K series of platinum. Under such high pressures there is always the risk that the tube will fail. Again, a very high vacuum must be present in the tube. In the case of a gas-filled tube this became a source of considerable difficulty, for, even when the requisite vacuum is obtained, the tube becomes very uncertain in operation, and, under the very best conditions, only a small current can be passed through the tube. In consequence, the X-rays produced possess

1. Phil. Mag. XXXVIII., Nov., 1919.
2. Proc. Nat. Acad. Sci., VI., 1920, p. 477.

but a small amount of energy, and have very little photographic effect. It is thus essential to have long exposures.

The photography of the lines is complicated still further by the photographic fog produced by the rays scattered by various parts of the apparatus (slits, crystal, etc.). Since the lines occur on the film very close to where the direct rays fall, the scattered rays are most intense just at the region where the lines are to be observed.

The one heavy element, the high frequency spectrum of which has been carefully investigated, is tungsten. Since this element has been used as the material of the target in the Coolidge type of tube, it is a comparatively easy matter to excite its K series spectrum. As there was no Coolidge type of tube with a platinum target available for this research, a gas-filled tube, made by Gundelach, was used.

The K series of platinum has been measured once previously —by Lilienfeld and Seeman,[3] who employed a Lilienfeld tube with a target of platinum-iridium. The values obtained by these authors are given in Table II.

The Spectrometer.

The whole of X-ray spectroscopy is based on the fact that a crystal acts as a space grating to X-rays. W. L. Bragg[4] showed that if a parallel beam of X-rays of wave-length λ was directed on a crystal face at an angle θ so that $\lambda = 2d \sin \theta$, there would be an interference maximum at an angle θ, and other maxima at values of θ given by $n\lambda = 2d \sin \theta$; n is here an integer and d is the lattice constant of the crystal, i.e., the distance between successive planes of atoms, parallel to the reflecting face. If, then, it is desired to resolve a beam of X-rays into its component parts, it is necessary that the crystal should be placed at different angles with respect to the incident beam. This is done most efficiently by rotating the crystal slowly and uniformly.

Further, W. H. Bragg[5] established that if a diverging beam of X-rays issued from a narrow slit S_1 (fig. 1(*b*)), and fell on a crystal face which was rotating about a point O (axis of rotation), and if a photographic film was placed round the circle

3. Phy. Zeit., XIX., 1918, p. 269.
4. X-Rays and Crystal Structure, p. 16.
5. X-Rays and Crystal Structure, p. 31.

FF′, which has O as centre, and OS_1 as radius, all the X-rays of a certain wave length λ would be reflected to a particular vertical line on the film. If there is present in the incident beam X-rays of a definite wave length, carrying more energy than those of adjacent longer and shorter wave legths, then its presence will be shown by a line on the film.

An additional advantage of a rotating crystal is that it gives much sharper lines than a stationary one, since the effect on the lines of surface defects of the crystal is thus considerably lessened.

No spectrometer being available, a Dancer theodolite was modified to have the movements of a spectrometer, and to fulfil the requirements of the focussing condition. It may be mentioned that a theodolite can be adapted to form a spectrometer, which is both accurate and convenient.

The circle carrying the scale was fixed by shrinking a brass ring on to its under surface at AA′ (fig. 1a). This ring was supported by a tripod mounted on the ring BB′, through which passed three levelling screws bearing on a stone table. The crystal holder was mounted on the vernier circle at D. The film holder was carried by an arm which screwed into the theodolite at E. Both crystal holder and film holder turned on conical bearings. The slits S_1 and S_2 were supported by a brass tube which screwed into the ring BB′.

The *crystal* was a large calcite one. The reflecting face (5.cm. x 2.cm.) was a ground cleavage one. As W. L. Bragg, James and Bosanquet[6] have shown, ground faces are more efficient reflectors than natural cleavage faces.

The *crystal holder* was so designed that the reflecting face of the crystal could be made vertical, and could be brought into the axis of rotation of the spectrometer.

The *film holder* was cut from a brass ring, the inside edge of which was accurately turned, its radius being 10.001 ± .001 cm. The film, in its paper casette, was tightly pressed against this by means of two curved strips of red fibre and clamping screws.

Slits.—The slit S_1, the tube slit, was made of an alloy of lead and antimony (75 per cent. lead), such an alloy being more durable than pure lead. The inside faces of this slit were carefully ground, and the slit width could be adjusted by a screw to 0.005. mm. The slit S_2 was made of lead, and was carried by the

6. Phil. Mag., XLI., 1921, p. 309.

same holder as S_1. This holder was constructed to allow the following adjustments: (a) It could be moved towards the axis of rotation of the spectrometer; (b) S_1 could be made vertical;

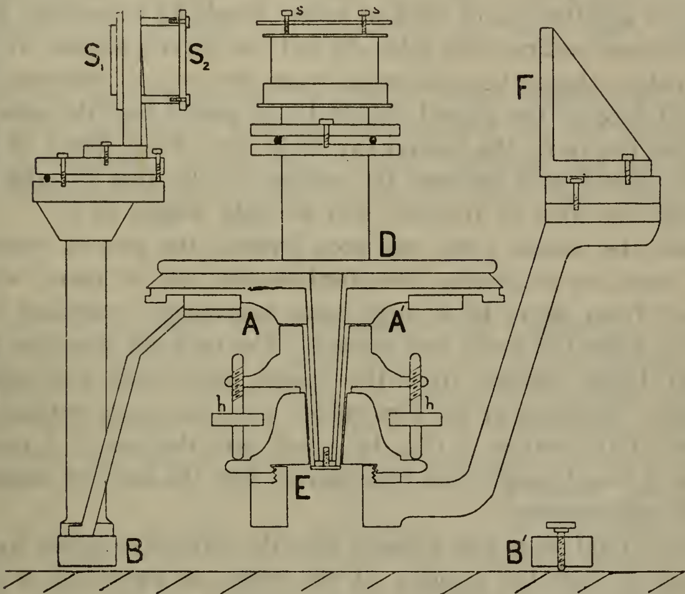

FIGURE 1A

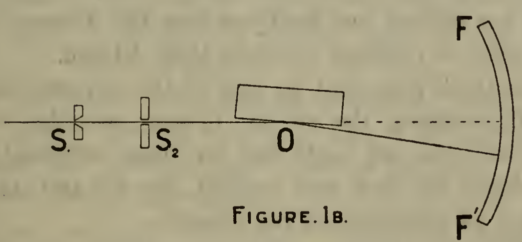

FIGURE. 1B.

DIAGRAM OF THE SPECTROMETER

(c) the line joining the centres of the slits could be made to pass through the axis of rotation.

Rotation Apparatus.—The vernier circle was rotated by means of a tangent screw. By means of a reduction gear, this was turned at 1/10,000th of the speed of a small motor. In the experiments, the rate of rotation of the crystal was about 2° per hour.

Adjustments.

The following are the essential requirements of a spectrometer of this type: The tube slit, the axis of rotation of the spectrometer and the axis of the film holder should all be parallel, and, in this case, vertical; the tube slit and the curved portion of the film holder should be equidistant from the axis of rotation; the ground face of the crystal should be so placed that the axis of rotation lies in it; the central ray from the "focal spot" of the target should pass through the centres of the slits S_1 and S_2, through the axis of rotation, and at right angles to it.

After the vernier circle had been levelled, the axis of rotation was found by so placing a vertical needle that its point, when viewed from above by a long focus microscope, remained stationary when the circle was rotated. The tube slit was then adjusted 10.cm. distant from the needle point, and was placed vertical. The axis of the film holder was next made vertical by means of the screws *h* (fig. 1a); and with the use of a centre tester, it was brought into coincidence with the axis of rotation of the spectrometer.

The crystal face was brought into the axis of rotation by so placing it, that the position of the edge, as viewed in a low power miscroscope, with its axis vertical, was in the same position both before and after the crystal had been rotated through 180°. The adjustment was carried out finally so that the distance of the face from the axis of rotation was less than .01.mm.

An optical method was used to test if the crystal face was vertical. By illuminating the slit S_1 it was possible to view, in a telescope, both the slit itself and its image reflected in the crystal face. When the face was vertical, the slit and its image were parallel for all positions of the crystal.

The slit S_1 was then so turned, and the crystal face was so placed that the light from the slit passed along the crystal face both before and after the crystal was rotated through 180°. This adjustment was carried out by means of a telescope, and it ensured that the ray from the centre of S_1 passed through the axis of rotation. The sides of the slit S_2 were then placed symmetrically with respect to those of S_1. In the experiments the widths of the slits were: S_1, 0.08. to 0.1.mm.; S_2, 0.6.mm.

The focal spots on the targets of both tubes were clearly marked. The focal spot in the case of the Coolidge tube was illuminated by lighting the filament, but for the Gundelach tube, light from a lamp was focussed on the target. The focal spot was viewed through a horizontal telescope, placed at the same height above the table as the centre of the crystal face, and the necessary adjustments for the central ray were easily carried out.

In the experiments described below it was necessary to adjust the focal spot of the Coolidge tube when it was not possible to use a telescope. In this case a mirror was used, and the images of the focus, slit and crystal face were viewed from above.

Experiment.

Tube.—The target of the Gundelach tube consisted of a platinum button attached to a stout copper rod, on the external end of which was a brass radiator. The potential difference applied to the tube was produced by a Snook-Victor high tension rectifier.

At the beginning of the research, the tube was too soft to excite the K series of platinum. The maximum pressure that could be applied to the tube was 60,000.volt. If the switches on the high tension rectifier were turned to increase the pressure, the only result was an increase in the current passing through the tube. It was found, however, that by keeping the current low —less than 0.5.m.a.—that the tube gradually hardened. After a fortnight's running, for several hours a day, a pressure of 85,000. volt could be applied to the tube. It was found difficult to maintain this potential difference, because fluctuations in the current became very big, and, with the increase in current there was the consequent drop in pressure.

After a considerable amount of experiment the following procedure was adopted. The tube was allowed to harden, so that there was practically no current, when a pressure of 95,000. volt was applied. Then, to begin an experiment, the tube was slightly softened, so that a current of 0.6.m.a. was obtained at 85,000.volt. If the current became less, the pressure was raised, and usually this gave an increase in current. The usual experience was, however, that the current, with the attendant fluctuations, increased after about 15.min., so that the corresponding falls in pressure were less than 80,000 volt. This was probably due to the target, as it became heated, giving off occluded gas. The pressure was then cut off from the tube for between

5. and 10 min., and, at the end of this time, the tube would be again in a condition suitable for use. To obtain lines sufficiently intense to measure, an exposure of 10,800 milliampere sec. was necessary. Since the average current through the tube was between .7. and .8.m.a., such an exposure required an experiment of at least six hours. The greater intensity of the radiation from a Coolidge tube was shown by the fact that more intense lines were obtainable from it in 5 min.

The *film used* was Eastman Dulpli-tized (photographic emulsion on both sides) which was placed between two Patterson intensifying screens. It has been stated that sharply defined lines cannot be obtained when intensifying screens are used. However, quite satisfactory lines were obtained, since under these conditions the α doublet of tungsten was resolved with a slit width of 0.12.mm. One great advantage of the doubly-coated film is its rigidity—there is no tendency to buckle during drying. Had intensifying screens not been used, the exposures would have been so long as to be practically impossible.

Protection from Scattered Radiation.—A sheet of aluminium 0.6.mm. thick was placed in front of the film to absorb the soft scattered radiation. In addition the rays reflected from the crystal were made to pass along a channel the sides of which were constructed of lead 3.mm. thick. This channel converged on all sides towards the crystal where its opening was a rectangle 2.cm. x 6.mm. This was large enough to allow both the direct rays and the lines to fall on the film.

Reference Lines.—The Pt. lines were photographed on the top half of each film, the lower part being covered with a lead screen. The Coolidge tube was then substituted for the Gundelach, and the W lines were photographed on the lower portion of the film. Since the film was held by the red fibre strips (vide page 198), there was no opportunity for it to slip during an experiment. The lines appeared as shown in figure 2. It will be seen that the α doublet of platinum falls between the α and β lines of tungsten. (The thickness of lines in the figure indicates relative intensities.)

Measurement of Lines.—The film was projected by a lantern, and a magnification up to 10 was obtained. The lines on each film were measured at three different magnifications, and the mean of the values so obtained was taken as the wave lengths of the lines given by the film.

A dividing engine, with a very accurate screw, was adapted for measuring the distance between the lines. A vertical board was carried by the moving platform of this engine. Two vertical lines 1.5.mm. apart were drawn on this board, and each line on

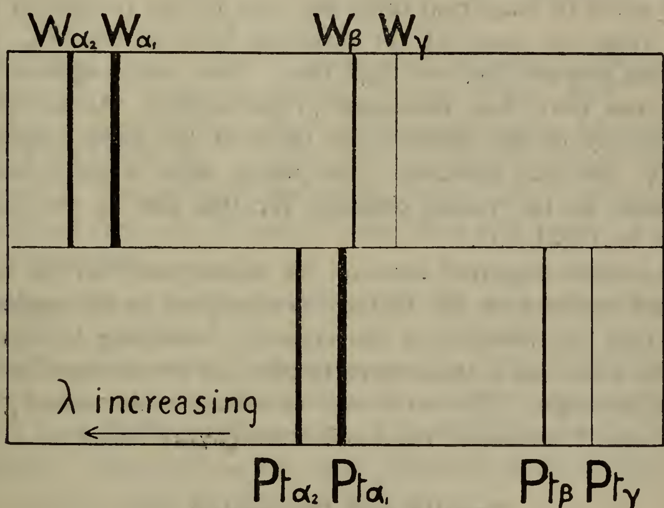

FIGURE 2.

the film was brought in turn exactly between these lines, and the reading of the engine noted. Table I. shows a set of such readings.

TABLE I. (Distances in mm.).

—	W.α_2.	W.α_1.	Pt.α_2.	Pt.α_1.	W.β.	W.γ.	Pt.β.	Pt.γ.
	0	1·13	5·87	7·10	7·25	8·51	12·46	13·66
	0	1·18	5·84	7·14	7·30	8·48	12·23	13·46
	0	1·15	5·90	7·18	7·29	8·50	12·38	13·47
	0	1·14	5·90	7·10	7·29	8·42	12·36	13·41
	0	1·15	5·88	7·22	7·33	8·41	12·29	13·50
Mean -	0	1·15	5·878	7·144	7·296	8·472	12·34	13·50

It will be seen that, for the fainter lines, e.g., the β and γ lines of Pt., there is much greater variation in setting than for the more intense lines. To evaluate the wave lengths the mean of

Siegbahn's and Duane and Stenstrom's values were assumed. These are as follow:—

$$\lambda \textit{ for } W\alpha_2 = \cdot 21347 \times 10^{-8}\text{cm}$$
$$W\alpha_1 = \cdot 20873 \;\;,, \;\;,,$$
$$W\beta = \cdot 18428 \;\;,, \;\;,,$$

The value in Angstrom units per mm. of the projection was found from the mean of the distances between the $W\alpha_2$ and $W\beta$ lines, and the $W\alpha_1$ and $W\beta$ lines. The wave lengths of the other lines were then calculated proportionally. As a test of the accuracy of the method, the value of the wave length of the $W\gamma$ line was obtained. The mean value is given below. The mean of the values obtained for this line by the above authors is .17921.A.U.

The method employed rests on the assumption that the wave lengths of the lines on the film are proportional to the angles at which they are reflected at the crystal. According to Bragg's formula, $\lambda = 2d \sin\theta$, these wave lengths are proportional to the sine of the angle. No error was introduced in the values given below since θ for $K\alpha_2 = 2°$(*q.p.*) and θ for Pt.$\gamma = 1°30'$(*q.p.*)

Results and Discussion.

In Table II. are given the values obtained. The wave lengths were calculated to five decimal places, and the final values are given to four places, with the probable error.

TABLE II. (λ in Angstrom Units).
Wave Lengths of K Series of Platinum.

Film No.	Pt.α_2.	Pt.α_1.	Pt.β.	Pt.γ.	W.γ.
P.14	·18939	·18496	·16455	·15955	·17952
P.15	·18926	·18536	·16427	·15968	·17905
P.16	·18998	·18502	·16429	·15942	·17973
Mean - -	·18954	18511	·16437	·15955	·17943
Final - -	·1895±2	·1851±1	·1644±2	·1596±2	·1794±2
Lilienfeld and Seeman	·1907	·1853	·1642	·1593	—

In the last line of the table the values obtained by Lilienfeld and Seeman are inserted for comparison. The agreement is good except for the Pt.α_2 line. The apparent discrepancy can be explained by the fact that these authors were unable to distinguish between the Pt.α_2 line and the Ir.α_1 line. The writer has found that if the K spectra of Pt. and W are photographed on the same portion of a film, it is impossible to recognise as separate lines, the Wβ ($\lambda = \cdot 1843$) and Pt.α_1($\lambda = \cdot 1851$)

Theory of Lines.—The K series of an element is excited when an electron is ejected from the K ring of the atom. If this electron is replaced from the L ring of the atom, the energy so freed gives rise to the α_1 line. If it is replaced from an electron from the L′ ring (an elliptical orbit), the α_2 line is excited. Replacements from the M and N rings give rise to the β and γ lines respectively.

Moseley's formula, $\frac{v}{R} = (N-1)^2(1/1^2 - 1/2^2)$, for the wave number v of the Kα_1 line, which accurately represents the observed values for low values of N, fails for elements of higher-atomic number. (R is here Rydberg's constant, N the atomic number of the element.) The value of the wave length of the Pt.α_1 line from this formula would be .2049 x 10^{-8} cm.

Sommerfeld has developed a formula for the wave number $v (= 1/\lambda)$, by considering the effective nuclear charge for the K and L rings as (N– 1.6) and (N–3.5) resp. and by taking into account the relative masses of the electrons in consequence of their velocity. The formula is:—

$$v/R = \frac{2}{\alpha^2}\left(\sqrt{1 - \frac{\alpha^2}{4}(N - 3\cdot 5)^2} - \sqrt{1 - \alpha^2(N - 1\cdot 6)^2}\right)$$

where $\alpha = \frac{2\pi e^2}{ch}$ e, c, h being the charge on the electron, the velocity of light and Planck's constant respectively. Hence $\alpha^2 = 5.3088 \times 10^{-5}$.

This formula gives λ for Kα_1 of Pt. $= \cdot 1837 \times 10.^{-8}$ cm.

A formula due to Kroo and Sommerfeld fits the observed value more accurately still. In this, before the passage of the atom, which gives rise to the Kα_1 line, the K ring is considered as a 1 quantum ring with 2 electrons, the L ring as a 2 quanta ring with 9 electrons. After the passage of the electron, the K ring is a 1 quantum ring with 3 electrons, and the L ring as a 2 quanta ring with 8 electrons. By calculating the energy difference between the two configurations, the following formula is obtained:—

$$\frac{v}{R}=\frac{2(k-1)}{\alpha^2}\sqrt{1-\alpha^2F_1}+\frac{2(l+1)}{\alpha^2}\sqrt{1-\alpha^2F_2}-\frac{2k}{\alpha^2}\sqrt{1-\alpha^2F_3}$$
$$-\frac{2l}{\alpha^2}\sqrt{1-\alpha^2F_4}$$

where $k=3$, $l=8$, $F_1=(N-S_{k-1})^2$, $F_2=\frac{1}{4}(N-k+1-S_{l+1})^2$, $F_3=(N-S_k)^2$, $F_4=\frac{1}{4}(N-k-S_l)^2$

and the S terms are obtained from

$$S_p=\frac{1}{4}\sum_{1}^{i=p-1}\frac{1}{\sin i\frac{\pi}{p}}$$

For Pt. this gives the values of $\lambda.K\alpha_1$ as $\cdot 1841\times 10^{-8}$ cm. The agreement with the observed value is remarkable, as the formula is a rational relation. This lends additional support to the Bohr-Sommerfeld theory of the atom.

Sommerfeld has also obtained the following formula for the difference in wave number Δv for the lines of the $K\alpha$ doublet:—

$$\frac{\Delta v}{(N-3\cdot5)^4}=\Delta v_H\left[1+\frac{5\alpha^2}{2}.\frac{(N-3\cdot5)^2}{2^2}+\frac{53\alpha^4}{8}.\frac{(N-3\cdot5)^4}{2^4}\;\ldots\ldots\right]$$

where Δv_H=frequency difference for hydrogen$=\frac{R\alpha^2}{2^4}$.

From the results of the experiment, given in Table II., $\Delta v\times 10^8=\cdot126\pm\cdot008$, while the above formula gives $\Delta v\times 10^8=\cdot135\pm\cdot002$.

It will be seen that the agreement is again fairly good.

In conclusion, the author wishes to express his indebtedness to Prof. T. H. Laby, M.A., Sc.D., F. Inst. P., for his invaluable guidance and advice throughout the whole of the research, and in the writing of this paper.

The Gundelach tube used in these experiments was presented to the Natural Philosophy Department, Melbourne University by W. Watson and Sons.

[Proc. Roy. Soc. Victoria, 34 (N.S.) Part II., 1922.]

Art. XXI.—*Contributions from the National Herbarium of Victoria.—No. 1.*

By J. R. TOVEY and P. F. MORRIS.

(With 2 Text Figures.)

(Communicated by Wm. Laidlaw, B.Sc.)

[Read 8th December, 1921.]

The present paper contains the descriptions of two species new to science, both from Western Australian localities. A new variety has also been established, a native of the alpine regions of Victoria, New South Wales and Tasmania. Three foreign plants have been recorded for the first time, whilst the orchid *Corysanthes bicalcarata,* a native of New South Wales, Queensland and Tasmania, has been added to the Victorian Flora. In addition several new records of the regional distribution of native and introduced plants are given.

It is proposed to continue these contributions as material becomes available and opportunity offers.

Aponogeton distachyum, Thunb. "Cape Pond Lily" (Naiadaceae).

Stony Creek, Lorne, Victoria, Rev. A. C. F. Gates, November, 1921.

This South African plant has escaped from cultivation, and is now spreading in several parts of the above-named creek, where it will no doubt become naturalised.

Bossiaea Laidlawiana, sp. nov. (Leguminosae).

Frutex arbuscula concinna, alta quindecim ad viginti pedes, rami tomentosi. Folia longa dimidiam partem unciae; lata circiter tres partes unciae, adversa, pedunculi breves, serrata, haud pungenter acuta aut alte sinuata codem modo quo B. Aquifolium. Nonnulla foliorum superiorum hirsuta infra. Flores, soli, axillarii, vexillum et alae flava, carina purpurea, flores in pediculis plerumque tam longi quam calyx, bracteae interiores et bracteolae persistentiores quam B. Aquifolium. Calyx longa unum ad unum et dimidium lignum, lobae duae superiores late truncatae tres inferiores, breviores, sed acutae. Vexillum ter tam longa quam

Fig. 1.—Bossiaea Laidlawiana, n.sp.
(1) Portion of plant in flower and fruit. (2) Flower dissected. (3) Legume. (4) Leaf. (5) Leaf of B.aquifolium.

calyx; petala inferiora paulum breviora, ovarium cum tribus ovulis. Legumen longa circiter tres partes unciae et lata unam partem unciae.

An elegant shrub, 15 to 20 feet high, branches tomentose. Leaves half inch long, about three-quarters inch broad opposite, shortly pedunculate, serrated, not pungently pointed or deeply sinuate as in *B. Aquifolium.* Some of the upper leaves hairy beneath. Flowers, solitary, axillary, standard and wings yellow, keel purplish red; flowers on pedicels usually as long as the calyx. Inner bracts and bracteoles more persistent than B. Aquifolium. Calyx, 1-1½ lines long; lobes, two upper ones broadly truncate, lower 3 shorter, but pointed. Standard 3 times as long as calyx, lower petals slightly shorter. Ovary, 3 ovules. Pod about ¾ inch long, and ¼ inch broad.

Pemberton and Manjimup, Warren district, West Australia, Max Koch, No. 2244 Oct., Dec., 1918; Western Australia (in National Herbarium, Melbourne, without collector's name or precise locality).

Its nearest affinity is *B. Aquifolium,* from which it differs in being a tomentose shrub of 15-20 feet, colour and size of flowers, shape of leaf, calyx and standard.

Named in honour of Wm. Laidlaw, B.Sc., Government Botanist for Victoria.

BROMUS TECTORUM, L. "Wall or Downy Brome-Grass" (Gramineae).

Parkville, near Melbourne, A. O'Brien, Nov., 1921.

This grass, a native of Europe and Asia, is introduced and widely spread in United States, America, where it is looked upon as a very objectionable grass, but it has not been previously recorded as growing wild in Victoria.

CALADENIA ANGUSTATA, Lindl. "Slender Caladenia" (Orchidaceae).

Hurst Bridge, Victoria, Miss S. Llewelyn, Oct., 1921.

A new locality in Victoria for this orchid.

CHORETRUM PENDULUM, sp. nov. (Santalaceae).

Pendens aut frutex arbuscula lacrimosa alta circiter sex pedes; folia redacta ad crustas minutas, satis persistentia, paulum curva ad apices acutas. Rami inferiores interstincti aut striati; ramusculi angulares exacute. Flores parvi (sed maiores quam C. lateriflorum), soli, pedunculi breves, corolla alba. Flores sparsi et cum longioribus intervallis quam in C. lateriflorum; quisque flos circumplexus ovi forma pravis bracteis et bracteolis. Ovarium inferius, stigma cum quinque lobis; fructus drupae aridae et flavae, et coronatae cum quinque lobis perianthialibus.

A pendant or weeping shrub about six feet high; leaves re-

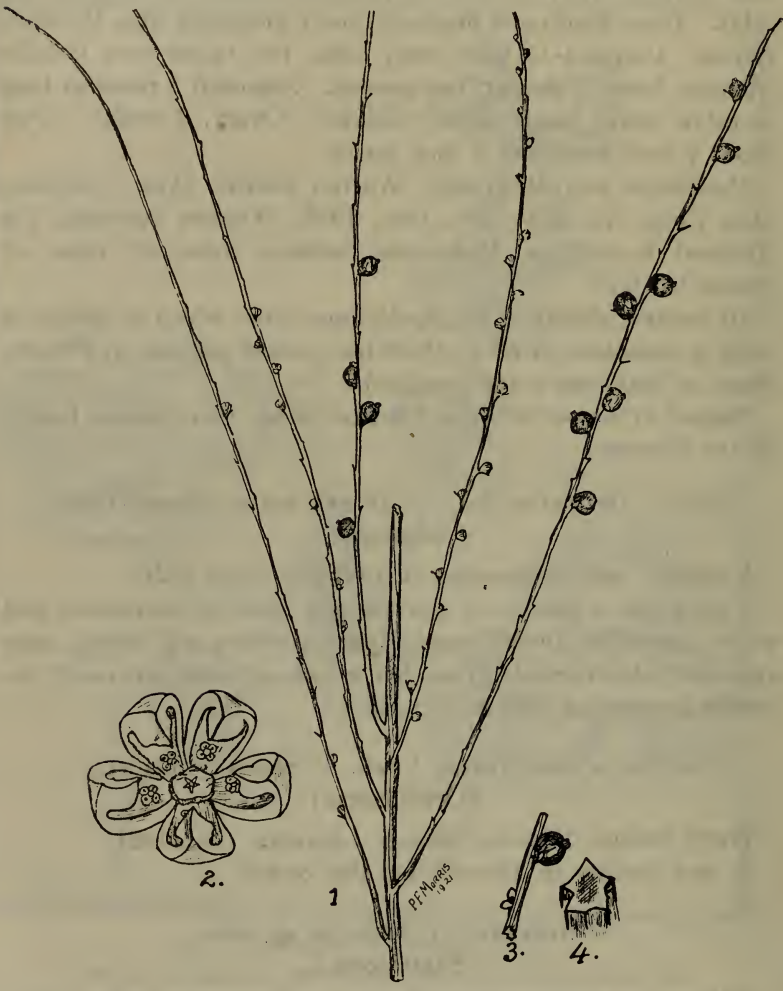

FIG. 2.—CHORETRUM PENDULUM, N.SP.
(1) Portion of plant in flower and in fruit. (2) Flower (enlarged).
(3) Fruit with bracts and bracteoles. (4) t.s. of stem.

duced to minute scales, fairly persistent, slightly curved at the pointed tips. Lower branches streaked or grooved, the branchlets acutely angular. Flowers small (but larger than in the type of C. lateriflorum), solitary very shortly pedunculate, corolla white. Flowers scattered and further apart than in *C. lateriflorum;* each flower surrounded by small oval bracts and bracteoles. Ovary inferior, stigma five lobed; fruit a dry globular drupe, yellow, and crowned with five perianth lobes.

Pemberton, Warren district, West Australia, Max Koch, No. 2409 (Oct., 1919), and No. 2537 (Jan., 1921).

Its nearest affinity is *C. lateriflorum* from which it differs in having larger flowers, height, the shape of branches, pendulous habit, fruit and stigma lobes, the bracts and bracteoles being more rounded, and the fruit on a shorter peduncle.

Mr. Spencer le Moore, of the British Museum, to whom a specimen was submitted for comparison with Brown's type of *C. lateriflorum,* says: "We received this some three years ago from Dr. Stoward, who met with it in the 'Albany District.' The specimens were in fruit only, and I was unable to name them. Now that the flowers have been found, there is apparently no doubt as to the plant's novelty."

CORYSANTHES BICALCARATA, R.Br., (Orchidaceae).

Healesville, Victoria, Miss D. Coleman, July, 1921.

Previously recorded from New South Wales, Queensland and Tasmania.

ERAGROSTIS CURVULA, Nees, var. VALIDA, Stapf.
"African Love Grass."

Government House Domain, Melbourne, Miss A. M. Tovey, Nov., 1921.

This South African grass was previously recorded from Drouin, Gippsland. The grass becomes too wiry to be of much use for fodder.

EURYOPS ABROTANIFOLIUS, D.C. "Southern wood-leaf Euryops" (Compositae).

Near Menzies' Creek, Paradise, Victoria, J. W. Audas, August, 1921.

This South African plant, may be regarded as an exotic not yet sufficiently established to be considered naturalised.

HELICHRYSUM ROSMARINIFOLIUM, Less, var. LEDIFOLIUM, comb. nov. (Syn. Helichrysum ledifolium, Benth.) Compositae.

Victoria: Mt. Hotham, C. Walter (no date), Mt. Hotham, 6000 feet, A. J. Tadgell, Dec., 1914; also found in New South

Wales and Tasmania. The branches of this variety are rather stouter, the leaves are more crowded and thicker; the flower heads are larger, but otherwise the inflorescence, involucres, florets, achenes and pappus quite as in *H. rosmarinifolium.*

LUZULA CAMPESTRIS, D.C., var. AUSTRALASICA, Buch. (syn. L. Oldfieldii, Hook, f.) (Juncaceae).

Bennison's Plain, Gippsland, A. W. Howitt, 1887, Hawkesdale, H. B. Williamson, May, 1899; Lorne, Rev. A. C. F. Gates, Nov., 1921.

This variety, a native of New South Wales and Tasmania, has now to be recorded for Victoria.

MELALEUCA ERICIFOLIA, Sm. "Swamp Paper-Bark" (Myrtaceae).

Epsom, near Bendigo, D. J. Paton, Nov., 1921.

A new locality in Victoria for this plant.

MOENCHIA ERECTA, Sm. "Upright Moenchia." (Caryophyllaceae.)

This plant, a native of Europe, was recorded under the name of *Cerastium quaternellum,* Fenzl., in Vict., Nat. X., p. 145 (1893) as a naturalised alien in Victoria. The genus *Moenchia* was then placed as a subgenus of *Cerastium,* but as *Moenchia* is now considered to be a valid genus, the specimens hitherto known in Victoria as *Cerastium quaternellum* have to be changed to *Moenchia erecta,* Sm.

This plant is also found in Tasmania.

NOTHOLAENA DISTANS, R.Br. "Bristly Cloak Fern." (Filices.)

Granite Rocks on Big Hill, near Bendigo. David J. Paton, January and May, 1921.

A new locality in Victoria for this fern.

ZIERIA ASPALATHOIDES, A. Cunn. "Hairy Zieria." (Rutaceae.)

Mt. Tarrangower, about 1300 feet, Maldon, Victoria, Rev. W. C. Tippett, Oct., 1921.

A new locality for this plant. It was previously recorded from the Grampians, A. Cunningham; and Barren ridges near Goulburn River, F. v. Mueller. It is also found in New South Wales and Queensland.

ANNUAL REPORT OF THE COUNCIL.

For the Year 1921.

The Council herewith presents to Members of the Society the Annual Report and Statement of Receipts and Expenditure for the past year.

The following meetings were held:—

March 10—Annual Meeting.

The following office-bearers retired by effluxion of time: President, Professor Ewart, D.Sc.; Vice-Presidents, F. Wisewould, Professor Laby; Hon. Treasurer, W. A. Hartnell; Hon. Librarian, ———; Hon. Secretary, J. A. Kershaw; Members of Council, Professor Osborne, Dr. Summers, Dr. Baldwin, Messrs. Dunn, Richardson, Picken.

The following were elected: President, Professor Ewart, D.Sc.; Vice-Presidents, F. Wisewould, Professor Laby; Hon. Treasurer, W. A. Hartnell; Hon. Librarian, A. S. Kenyon; Hon. Secretary, J. A. Kershaw; Members of Council, Professor Osborne, Dr. Summers, Dr. Baldwin, Messrs. Dunn, Richardson, Picken.

The Annual Report of the Council and Financial Statement were read and adopted.

At the close of the annual meeting an ordinary meeting was held. The following paper was read: (1) "Blood and Shade Divisions of Australian Tribes," by Sir Baldwin Spencer, K.C.M.G., F.R.S., D.Sc. Exhibit: Extracts from Mach's "Science of Mechanics," as bearing upon the Theory of Relativity, by Mr. D. K. Picken. Dr. J. M. Lewis was elected a member.

April 14th:—Paper: "The Age of the Ironstone Beds of the Mornington Peninsula," by Frederick Chapman, A.L.S. Professor W. E. Agar delivered a lecture on "Physical Basis of Heredity."

Mr. Studley Miller and Captain Edward Kidson, O.B.E., M.Sc., were elected members; Captain R. E. Trebilcock, M.C., a country member; and Dr. Gwynneth Buchanan, Mr. Aubrey Reader, and Mr. Alister Burns, associates.

May 12th:—Papers: (1) "The Australian Species of Carex in the National Herbarium, Victoria," by J. R. Tovey; (2) "Notes on Amycterides, with Descriptions of New Species," Part III., by Eustace W. Ferguson, M.B., Ch.M.; (3) "The Specific Name of the Australian Aturia and Its Distribution," by Frederick Chapman, A.L.S.

Mr. Howard R. Archer, B.Sc. was elected an associate.

July 9th:—Paper: "New Australian Coleoptera, with Notes on Some Previously Described Species," Part I., by F. Erasmus Wilson (communicated by J. A. Kershaw). A lecture was delivered by Professor Orme Masson on "The Structure of the Atom."

July 14th:—Papers: (1) "An Intercomparison of Important Standard Yard Measures," by J. M. Baldwin, M.A., D.Sc.; (2) "The Petrology of the Ordovician Sediments of the Bendigo District," by J. A. Dunn, B.Sc. (Howitt Natural History Research Scholar in Geology); (3) "On an Inclusion of Ordovician Sandstone in the Granite of Big Hill, South of Bendigo," by J. A. Dunn, B.Sc. (Howitt Natural History Research Scholar in Geology); (4) "The Euclidean Geometry of Angle," by D. K. Picken, M.A.

Messrs. F. E. Wilson, J. Cronin, and N. Rosenthal were elected associates.

August 11th:—Paper: "An Alphabetical List of Victorian Eucalypts," by J. H. Maiden, I.S.O., F.R.S., F.L.S. A lecture on "The Development of Horticultural Varieties of Various Plants," was given by Mr. J. Cronin. A series of botanical specimens were exhibited to illustrate the lecture.

Mr. Stanley S. Addison was elected a member.

September 8th:—Papers: (1) "The Rotifera of Australia and Their Distribution," by J. Shephard; (2) "Local Rain Producing Influences in South Australia," by E. T. Quayle, B.A.; (3) "On a New Type of Barometer," by T. H. Laby, M.A.; (4) "On a Gravity Metre," by T. H. Laby, M.A. Mr. F. Chapman delivered a lecture on "The Importance of Fossils in Regard to Oil-Finding in Australia." The lecture was illustrated by a series of lantern slides. Exhibits: Professor T. H. Laby showed, (1) "Standard Nickel Metre, which has been compared with the International Prototype Metre;" and (2) "A Set of Slip Gauges."

October 13th:—Paper: "Development of Endosperms in Cereals," by M. Gordon, B.Sc. Mr. J. A. Smith delivered a lecture on "Genesis of Energy," illustrated by lantern slides and exhibits. Mr. E. T. Quayle, B.A., was elected a member.

November 10th:—Papers: (1) "Present and Probable Distribution of Wheat, Sheep and Cattle in Australia," by G. Thomas, B.Ag.Sc. (communicated by A. E. V. Richardson, M.A., B.Sc.); (2) "Additions and Alterations to the Catalogue of Victorian Marine Mollusca," by J. H. Gatliff and C. J. Gabriel; (3) "Gold Specimens from Bendigo, and Their Probable Modes of Origin," by F. L. Stillwell, D.Sc.; (4) "On a Fossil Filamentous Alga and Sponge-Spicules Forming Opal Nodules at Richmond River, New South Wales," by Frederick Chapman, A.L.S. Exhibit: "Variation in Some Fossil Species," by F. Chapman.

December 8th:—Messrs. J. E. Gilbert and A. E. V. Richardson, M.A., B.Sc., were elected Honorary Auditors. Papers: (1) "On the Changes of Volume in a Mixture of Dry Seeds and Water," by Alfred J. Ewart, D.Sc., Ph.D., F.L.S.; (2) "Further Researches into the Serological Diagnosis of Pleuro-Pneumonia of Cattle," by G. G. Heslop, M.V.Sc., D.V.H.; (3) "The High Frequency K Series Emission Spectra of Platinum," by J. S. Rogers, B.A., B.Sc.; (4) "The High Frequency K Series Emission Spectra of Tantalum," by H. C. J. Asche, B.C.E., B.Sc.; (5) "Separation of Mercury into Fractions of Different Densities," by W. G. Mepham, B.Sc.; (6) "The Mechanical Equivalent of Heat: Preliminary Determinations," by T. H. Laby, M.A., Sc.D., F.Inst.P., and E. O. Hercus, M.Sc.; (7) "Contributions from the National Herbarium of Victoria, No. 1," by J. R. Tovey and P. F. Morris (communicated by W. Laidlaw, B.Sc.).

Exhibit: Mr. J. A. Kershaw, on behalf of the National Museum, showed a meteorite from the Roper River, N. Territory. The specimen, which weighs about 14 lbs., was found by an aborigine in open forest country, while mustering cattle.

During the year five members, one country member, and seven associates were elected, including one associate elected as a member.

The Council regrets to record the loss by death of Mr. M. O. Copland, B.M.E., of the Ballarat School of Mines, and Captain Kenneth Aubrey Mickle, D.S.O.

Maurice Osric Copland, who died August 1st, 1920, was a Country Member of this Society, having been elected in 1917. At the time of his decease he was Principal of the Ballarat School of Mines. He was a native of Victoria, educated at Wesley College, and graduated B.M.E. at Melbourne University. He had a varied experience in Victoria, South Africa, Queensland, and Western Australia. In South Africa he was Petrologist under Dr. Hatch, and was also engaged in work connected with gold, coal, and diamond mining in that country. His breakdown in health was attributed to his wholehearted zeal in working out repatriation and vocational training schemes after the war, whilst at Ballarat. Mr. Copland left behind a remarkably good record of unselfish work in his particular sphere, and much of the success of the research on the white earthenware industry is due to him, the Bureau of Science and Industry at his suggestion providing a scholarship for the investigation of this subject.

In 1905, Mr. Copland published a bulletin on the Monazite Deposit of the Borang District, E. Gippsland, for the Geological Survey of Victoria.

Kenneth Aubrey Mickle (Capt.), D.S.O., died on 30th July, 1919, at 30 Marine Parade, St. Kilda, after a long illness from the effects of gas received in action in France. Capt. Mickle was the son of Clara and the late David Mickle, and was 33 years of age. He was educated at Queen's College, and, after qualifying as a metallurgist, conducted research work at Melbourne University for three years. There he won the Grimwade prize and other distinctions. On the outbreak of war he was chief chemist at the Burma Mines Ltd., Upper Burma. He enlisted in England in the Royal Garrison Artillery, and received a commission, being promoted to captain for bravery in the field. He had command of the 9th Division Trench Mortar Brigade, and was decorated with the Distinguished Service Order. He saw much fighting on the Somme and at Arras. He was an Associate of our Society. His death cut short an exceptionally promising career, and he leaves many friends to mourn their loss.

The interest in the work of the Society is evidenced by the satisfactory attendances at the usual monthly meetings. The papers submitted were well up to the usual standard, and the subjects dealt with covered a wide field of research.

The attendances at the Council meetings were as follow:—Professor Ewart, 9; Professor Skeats, 9; Dr. Summers, 9; Mr. Richardson, 9; Mr. Kershaw, 9; Dr. Baldwin, 8; Mr. Wisewould, 8; Mr. Chapman, 8; Mr. Shephard, 7; Mr. Dunn, 7; Professor Agar, 5; Professor Osborne, 5; Dr. Green, 5; Professor Laby, 3; *Mr. Hartnell, 3; Mr. Picken, 3; *Mr. Herman, 2; Mr. Kenyon, 2.

Owing to serious illness, Mr. Hartnell, who has occupied the position of Hon. Treasurer continuously for the past thirteen years, was compelled to relinquish the duties of the position, which Mr. Shephard kindly undertook to carry on for the remainder of the year. Mr. Hartnell has taken a very keen interest in the work of the Society, and carried out the duties of Treasurer in a particularly conscientious manner. His resignation was received with great regret, and the Council's appreciation of his valued services has been placed on record.

The Librarian reports that 1463 volumes and parts were added to the Library during the year. The work of revising the card catalogue has been continued, and by a re-arrangement of the books on the shelves an appreciable amount of space has been gained. It is to be regretted that want of funds will not allow of much necessary binding.

Volume XXXIII. of the Proceedings was issued on the 9th May, and Part I. of Volume XXXIV. on the 31st October. Part II. of the same Volume is now well advanced, and should be available for issue at an early date.

During the year the delivery of short popular lectures on subjects of general interest was continued. These were given by Professor W. E. Agar, Professor Orme Masson, and Messrs. J. Cronin, F. Chapman, and J. A. Smith, and were well attended.

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* Absent on leave and through illness.

Financial Statement for the year ending 28th February, 1922.

RECEIPTS.

Balance at 1st February, 1921		£95 13 0
Subscriptions—		
Members	£144 18 0	
Associates and Country Members	95 7 6	
		240 5 6
Rents—		
Com'wealth Government	£25 0 0	
Field Naturalists' Club...	12 0 0	
		37 0 0
Sales of Publications		1 1 0
Victorian State Government Grant in Aid		100 0 0
Drawn for Distribution and Unexpended ...		4 10 0
		£478 9 6

EXPENDITURE.

Publication—		
Printing	£278 7 6	
Distribution	38 10 0	
		£316 17 6
Maintenance—		
Assistant Secretary ...	£30 0 0	
Assistant Librarian ...	12 0 0	
Caretaker's A/cs. ...	19 1 2	
Rates	7 13 8	
Repairs	9 13 9	
Insurance...	5 1 3	
Petty Cash	6 0 0	
Sundries—Gas, Electric Light, etc.	6 0 4	
		95 10 2
Cash Charges—		
Commission	25 11 6	
Cheque Book	1 0 0	
		26 11 6
Library		8 2 6
Balance at 28th Feb., 1922		31 7 10
		£478 9 6

J. SHEPHARD, *Acting Hon. Treas.*

We have examined Pass Books and hereby certify that all amounts entered herein have been paid to the credit of the Society. We have seen receipts for all payments.

JAMES E. GILBERT, } *Hon.*
A. E. V. RICHARDSON, } *Auditors.*

7/3/22

N.B.—Liability for printing has been incurred estimated at £187.

Royal Society of Victoria.

1921.

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LIST OF MEMBERS

WITH THEIR YEAR OF JOINING.

[Members and Associates are requested to send immediate notice of any change of address to the Hon. Secretary.]

Patron.

His Excellency The Right Hon. The Earl of Stradbroke

Honorary Members.

Liversidge, Professor A., LL.D., F.R.S., "Field-head," George-road, Coombe Warren, Kingston, Surrey, England. 1892

Verbeek, Dr. R. D. M., Speelmanstraat, 19, s'Gravenhage, Holland. 1886

Life Members.

Fowler, Thos. W., M.C.E., Duncan's-road, via Werribee 1879

Gilbert, J. E., 13 Edward-street, Kew, Vic. 1872

Gregory, Prof. J. W., D.Sc., F.R.S., F.G.S., University, Glasgow. 1900

Love, E. F. J., M.A., D.Sc., F.R.A.S., Moreland Grove, Moreland. 1888

Selby, G. W., "Lindisfarne" Scott-grove, E. Malvern. 1881

Smith, W. Howard, "Moreton," Esplanade, St. Kilda ... 1911

Sticht, Rt., B.Sc., M.Am.Inst.M.E., Mt. Lyell Mine, Queenstown, Tasmania. 1913

Ordinary Members.

Addison, Stanley, University, Melbourne 1921

Agar, Prof. W. E., F.R.S., M.A., D.Sc., University Melbourne. 1920

Baker, Thomas, Bond-street, Abbotsford 1889

Bale, W. M., F.R.M.S., Walpole-street, Kew 1887

Baldwin, J. M., D.Sc., Observatory, South Yarra 1915
Balfour, Lewis, B.A., M.B., B.S., Burwood-road, Hawthorn. 1892
Baracchi, Pietro, F.R.A.S., George Hotel, St. Kilda ... 1887
Barrett, A. O., 25 Orrong-road, Armadale 1908
Barrett, Sir J. W., K.B.E., C.M.G., M.D., M.S., Collins-street. Melb. 1910
Boys, R. D., B.A., Public Library, Melb. 1903
Brittlebank, C. C., "Queensgate," St. George's-road, Elsternwick. 1898

Chapman, F., A.L.S., National Museum, Melb. 1902
Cudmore, F. A., 17 Murphy-street, South Yarra 1920

Davis, Captain John King, "Tasma," Parliament-place, Melbourne. 1920
Deane, H., M.A., M.Inst.C.E., 14 Mercer-road, Malvern 1914
Dunn, E. J., F.G.S., "Roseneath," Pakington-street, Kew. 1893
Dyason, E. C., B.Sc., B.M.E., 60 Queen-street, Melb. 1913

Ewart, Prof. A. J., D.Sc., Ph.D., F.L.S., University, Melb. 1906

Garran, Sir R. R., St. George's-road, Toorak 1914
Gault, E. L., M.A., M.B., B.S., Collins-street, Melb. 1899
Gilruth, J. A., D.V.Sc., M.R.C.V.S., F.R.S.E., 520 Munro-street, South Yarra. 1909
Goodwin, W. W., Esq., Commonwealth Lands and Survey Branch, Melbourne. 1920
Gray, Wm., M.A., B.Sc., Presbyterian Ladies' College, East Melb. 1913
Green, W. Heber, D.Sc., University, Melbourne 1896
Grimwade, W. Russell, B.Sc., 335 Spencer-street, Melb. 1912
Grut, P. de Jersey, F.R.Met.S., 103 Mathoura-road, Toorak. 1869

Hartnell, W. A., Burke-road, Camberwell 1900
Herman, H., B.C.E., M.M.E., F.G.S., "Albany," 8 Redan-street, St. Kilda. 1897
Higgin, A. J., F.I.C., University, Melb. 1912
Horne, Dr. G., Lister House, Collins-street, Melbourne 1919

Kendall, W. T., D.V.Sc., M.R.C.V.S., 36 Park-street, Brunswick, Vic. 1911
Kenyon, A. S., C.E., Lower Plenty-road, Heidelberg ... 1901

Kelly, Bowes, Glenferrie-road, Malvern. 1919
Kernot, W. N., B.C.E., University, Melb. 1906
Kershaw, J. A., F.E.S., National Museum, Melb. 1900
Kidson, E., O.B.E., M.Sc., Meteorological Bureau, Melb. 1921

Laby, Prof. T. H., M.A., Sc.D., F.Inst.P., University, Melb. 1915
Laidlaw, W., B.Sc., Department of Agriculture, Melb. 1911
Lewis, J. M., D.D.Sc., "Whitethorn," Boundary-road, Burwood. 1921
Littlejohn, W. S., M.A., Scotch College, Melb. 1920
Lyle, Prof. T. R., M.A., D.Sc., F.R.S., Irving-road, Toorak. 1889
Loughrey, B., M.A., M.B., B.S., M.C.E., 1 Elgin-street, Hawthorn. 1880

Mackay, A. D., M.M.E., B.Sc., 4 Fawkner-street, South Yarra. 1920
MacKenzie, Colin W., M.D., B.S., F.R.C.S., 88 Collins-street, Melb. 1910
McPherson, The Hon. W. M., M.L.A., Coppin-grove, St. James' Park, Hawthorn. 1913
Mahony, D. J., M.Sc., "Lister House," Collins-street, Melb. 1904
Masson, Prof. Orme, M.A., D.Sc., F.R.S.E., F.R.S., University, Melb. 1887
Merfield, C. J., Observatory, South Yarra 1913
Michell, J. H., M.A., F.R.S., 52 Prospect Hill-road, Camberwell. 1900
Millen, The Hon. J. D., Batman House, 103 William-street, Melb. 1920
Miller, Leo., Melbourne Mansions, Collins-street, Melb. 1920
Miller, E. Studley, "Glynn," Kooyong-road, Malvern 1921
Monash, Lieutenant-General Sir John, G.C.B., M.C.E., B.A., LL.B., 360 Collins-street, Melb. 1913

Nanson, Prof. E. J., M.A., University, Melb. 1875

Oliver, C. E., M.C.E., Metropolitan Board of Works, Spencer-street, Melb. 1878

Osborne, Prof. W. A., M.B., B.Ch., D.Sc., University, Melb. 1910
Owen, W. J., "Gaergybi," 935 Rathdown-street, Nth. Carlton. 1919

Payne, A. T., "Scotsburn," Toorak 1911
Payne, Prof. H., M.Inst.C.E., M.I.M.E., University, Melb. 1910
Picken, D. K., M.A., Ormond College, Parkville 1916
Pratt, Ambrose, M.A., 376 Flinders-lane, Melb. 1918

Quayle, E. T., B.A., Meteorological Bureau, Melb. ... 1920

Richardson, A. E. V., M.A., B.Sc., Agricultural Department, Melb. 1912

Schlapp, H. H., 31 Queen-street, Melb. 1906
Shephard, John, "Norwood," South-road, Brighton Beach. 1894
Skeats, Prof. E. W., D.Sc., A.R.C.S., F.G.S., University, Melb. 1905
Spencer, Prof. Sir W. Baldwin, K.C.M.G., M.A., D.Sc., F.R.S., "Darley," Upper Fern Tree Gully. 1887
Summers, Associate Prof. H. S., D.Sc., University, Melb. 1902
Sutton, Harvey, M.D., B.S., Dept. Public Instruction, Sydney, N.S.W. 1913
Sweet, Associate Prof. Georgina, D.Sc., University, Carlton. 1906
Swinburne, Hon. G., M.Inst.C.E., M.Inst.M.E., "Shenton," Kinkora-road, Hawthorn. 1905
Syme, G. A., M.B., M.S., F.R.C.S., 19 Collins-street, Melb. 1913
Syme, Geoffrey, "Banool," Studley Park-road, Kew ... 1913

Taylor, R., 31 Queen-street, Melb. 1907
Taylor, Assoc. Prof. Griffith, B.A., B.E., D.Sc., University, Sydney, N.S.W. 1918
Thom, L. N., B.Sc., Patent Office, Melbourne 1910

Walcott, R. H., Technological Museum, Melb. 1897
Wisewould, F., 408 Collins-street, Melb. 1902
Woodruff, Prof. H. A., M.R.C.S., L.R.C.P., M.R.C.V.S., Veterinary School, University, Melb. 1913

COUNTRY MEMBERS.

Allen, G. M., F.R.M.S., Stribling's Buildings, Euroa.	1913
Armitage, R. W., M.Sc., F.G.S., F.R.G.S., 95 Foam Street, Elwood.	1907
Bowclay, W., "Rawson," 34 Newcastle-street, Rose Bay, Sydney, N.S.W.	1919
Collyer, W. J., M.Sc., 115 Raglan-street, Ballarat ...	1919
Crawford, W., Gisborne	1920
Dare, J. H., B.Sc., Elementary High School, Warracknabeal.	1917
Drevermann, J., Longerenong Agricultural College, Dooen.	1914
Easton, J. G., Geological Survey, Corryong	1913
Ferguson, E. W., M.B., Ch.M., "Timbrebongie," Gordon-road, Roseville, Sydney, N.S.W.	1913
Harris, W. J., B.A., High School, Kyneton	1914
Hogg, H. R., 7 St. Helen's Place, London, E.C.	
Hope, G. B., B.M.E., Gordon Technical College, Geelong.	1918
James, A., B.A., B.Sc., High School, St. Arnaud	1917
Kewish, P. D., B.A., B.Sc., Commonwealth Transcontinental Railway, South Australia.	1919
Kitson, A. E., F.G.S., 109 Worple-road, Wimbledon, London S.W., England.	1894
Langford, W. G., M.Sc., B.M.E., Vailala Oilfields, Papua.	1918
Lea, A. M., F.E.S., Museum, Adelaide, S.A.	1909
Richards, Prof. H. C., D.Sc., University, Brisbane, Queensland.	1909
Roberts, J. K., Cavendish Laboratory, Cambridge, England.	1919
Trebilcock, Captain, R. E., M.C., Wellington-street, Kerang.	1921
Whitelaw, H. S., Geological Survey Office, Bendigo. ...	1914

Corresponding Members.

Dendy, Professor Arthur, D.Sc., F.R.S., Sec. L.S., King's College, London. 1888

Lucas, A. H. S., M.A., B.Sc., Sydney Grammar School, Sydney, N.S.W. 1895

Merrel, F. P., Rhodesian Museum, Buluwayo, South Africa. 1919

Associates.

Allen, Miss N. C. B., B.Sc., Physics Dept., University, Melb. 1918

Archer, Miss E., M.Sc., 140 Park-street, Parkville ... 1917

Archer, Howard R., B.Sc., Geology School, University 1921

Ashton, H., "The Sun," Castlereagh-street, Sydney, N.S.W. 1911

Bage, Mrs. Edward, "Cranford," Fulton-street, St. Kilda, 1906

Bage, Miss F., M.Sc., Women's College, Kangaroo Point, Brisbane, Queensland. 1906

Baker, F. H., 167 Hoddle-street, Richmond 1911

Barkley, H., Meteorological Bureau, Melb. 1910

Bordeaux, E. F. J., G.M.V.C., B.ésL., 427 Mount Alexander-road, Moonee Ponds. 1913

Brake, J., B.Sc., Yering 1913

Breidahl, H., M.Sc., M.B., B.S., 36 Rouse-street, Port Melb. 1911

Brodribb, N. K. S., Cordite Factory, Maribyrnong 1911

Bryce, Miss L. M., B.Sc., Biology School, University, Melb. 1918

Buchanan, G., D.Sc., University, Melb. 1921

Burns, A., c/o Miss Stirling, "Roslyn," Salisbury-road, Rose Bay, Sydney, N.S. Wales. 1921

Carton, M., M.A., University, Melb. 1913

Chapple, Rev. E. H., The Manse, Warrigal-road Oakleigh. 1919

Clendinnen, F. W. J., "Haven," Hawksburn 1918

Clinton, H. F., Produce Office, 605 Flinders-street, Melb. 1920

Cook, G., M.Sc., B.M., Elphin-grove, Hawthorn 1919

Cookson, Miss I. C., B.Sc., 154 Power-street, Hawthorn 1916

Coulson, A. L., M.Sc., "Finchley," King-street, Elsternwick. 1919
Crespin, Miss R., Geology School, University, Melb. ... 1919
Cronin, J., Botanical Gardens, South Yarra 1921

Danks, A. T., 391 Bourke-street West, Melb. 1883

Fenner, C. A., D.Sc., Education Department, Flinders-street, Adelaide, S.A. 1913
Fenton, J. J., 20 Northcote-road, Armadale 1910
Ferguson, W. H., 37 Brinsley-road, E. Camberwell ... 1894
Finney, W. H., 40 Merton-street, Albert Park 1881

Gabriel, C. J., 293 Victoria-street, Abbotsford 1908
Gatliff, J. H., 5 Fawkner-street, S. Yarra 1898
Gordon, Miss M., B.Sc., Botany School, University, Melb. 1919

Hardy, A. D., F.L.S., Forest Department, Melb. 1903
Hart, T. S., M.A., B.C.E., F.G.S., Scoresby 1894
Hauser, H. B., B.Sc., Geology School, University, Melb. 1919
Hoadley, C. A., M.Sc., B.M.E., c/o Richardson Gears, Footscray. 1910
Holmes, W. M., M.A., B.Sc., University, Melb. 1913
Howitt, A. M., Department of Mines, Melb. 1910
Hunter, Stanley B., Department of Mines, Melb. 1908

Jack, A. K., M.Sc., "Kilkerran," Williams-street, Brighton. 1913
Jobbins, G. G., Electric Lighting and Traction Co., Geelong. 1902
Jona, J. Leon, M.D., B.S., D.Sc., 16 Collins-street, Melb. 1914
Junner, N., M.Sc., M.C., Gold Coast Geol. Survey, London. 1912
Jutson, J. T., B.Sc., "Oakworth," 2 Austin-avenue, St. Kilda. 1902

Keartland, Miss B., B.Sc., Cramer-street, Preston ... 1919
Keble, R. A., Department of Mines, Melb. 1911

Lambert, C. A., Bank of N.S.W., Melbourne 1919
Luher, R. E., B.A., 101 Hickford-street, E. Brunswick 1919
Luly, W. H., Department of Lands, Public Offices, Melb. 1896

McInerney, Miss K., M.Sc., Geology School, University, Melb. 1918
Macdonald, B., Meteorological Bureau, Melbourne ... 1920
Mackenzie, G., 1 High-street, Prahran 1907
Maclean, C. W., "Devon," Merton-avenue, Elsternwick 1879
Malcolm, L. W. G., c/o Royal Colonial Institute, Northumberland-avenue, London, W.
McLennan, Ethel, D.Sc., Botany School, University, Melb. 1915
Melhuish, T. D. A., B.A., Port Pirie, South Australia 1919
Mollison, Miss E., M.Sc., Royal Crescent, Camberwell 1915
Montgomery, J. N., Upoia Oilfield, Papua 1912
Moore, F. E., M.B.E., 4 Mont Albert-road West, East Kew. 1920
Morris, M., M.Sc., Langwarrin 1912

Nicholson, Miss Margaret G., 59 Murray-street, Elsternwick. 1920

O'Neill, W. J., Lands Dept., Melb. 1903
Osborne, Miss A., B.Sc., Biology School, University, Melb. 1918

Patton, R. T., B.S., M.F., Biology School, University, Melb.
Pern, Dr. Sydney, 16 Collins-street, Melb. 1920
Peterson, Miss K., B.Sc., Biology School, University, Melb. 1919
Piesse, E. L., Prime Minister's Dept., Melb. 1921

Raff, Miss J., M.Sc., University, Melb. 1910
Reader, Aubrey, Koornang-road, Carnegie 1921
Ritchie, E. G., M.Inst.C.E., Met. Board of Works, Spencer-street, Melb. 1909
Rivett, Assoc. Prof. A. C. D., M.A., D.Sc., University, Melb. 1914
Rosenthal, Newman H., 427 Cardigan-street, Carlton 1921
Rossiter, Captain A. L., M.Sc., University, Melb. 1913
Rossiter, Mrs. A. L., M.Sc., University, Melb. 1911

Scott, T. F., M.A., High School, Warragul 1917
Sharman, P. J., M.Sc., "Glenalvie," 9 Daphne-street, Canterbury. 1916

Singleton, F. A., M.Sc., Geology School, University, Melb. 1917
Smith, J. A., 15 Collins-place, Melb. 1905
Stickland, W., Thomas-street, Black Rock 1914
Stillman, Miss G., Botany School, University, Melb. ... 1919
Stillwell, F. L., D.Sc., 44 Elphin-grove, Hawthorn ... 1910
Sutton, C. S., M.B., B.S., Rathdown-street, N. Carlton 1908

Teale, E. O., D.Sc., F.G.S., F.R.G.S., "Coleraines," 34 Plough-lane, Lutley, Surrey, England 1898
Thorn, Wm., Mines Department, Melb. 1907
Tovell, C. M., M.Sc., Scotch College, Launceston, Tas. 1913
Traill, J. C., B.A., B.C.E., 630 St. Kilda-road.. 1903
Trüdinger, W., Gerald-street, Murrumbeena 1918

Weatherburn, C. E., D.Sc., M.A., Ormond College, Parkville. 1914
Webster, R., M.D., "The Eyrie," Eaglemont, Heidelberg. 1918
White, R. A., B.Sc., School of Mines, Bendigo 1918
Whitelaw, O. A. L., Geological Survey, Melb. 1913
Williamson, H. B., "The Grange," Corner Waverley-road, East Caulfield. 1919
Wilson, F. E., "Jacana," Darling-road, E. Malvern 1921
Woodward, J. H., Queen's Buildings, Rathdown-street, Carlton. 1903

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The names of new genera and species are printed in italics.

END OF VOLUME XXXIV.

[PART II. PUBLISHED MAY 31st, 1922].